POWER

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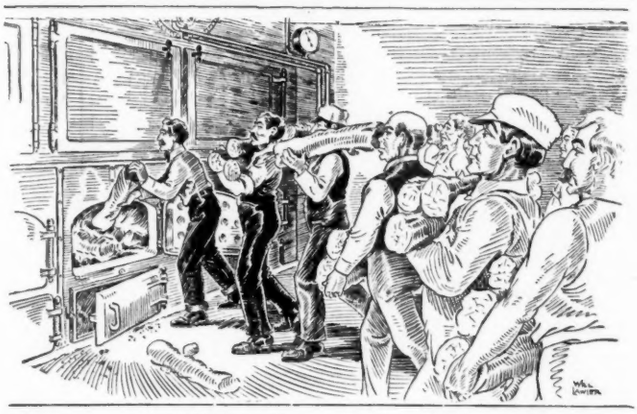
HELPFUL HINTS



Team Work in the Plant

The tendency toward specialization has penetrated the power plant no less than every other establishment devoted to productive service. As organizations are perfected, the duties of individuals are often restricted as to responsibility, and where this policy is carried to extremes, men are sometimes tempted to lose interest in each other's work. The larger efficiency of the service suffers accordingly, and can only be restored by team play. Upon the personality of the chief engineer much depends in this connection.

No plant can be organized solely like a machine and achieve the best results. Conditions are different from those in the mill or shop, where a tangible product is passed rapidly through the establishment, seen of men as it goes from step to step, ponderable and real. We cannot operate a power plant on the piecework basis. Between certain periods a measure of relief comes to the staff on duty; at other times the pressure rises and puts a heavy strain on part of the force. When these strains are noncoincident a little extra help may accomplish wonders.

Just because a fire wall separates the engine and boiler rooms shall the men on either side of the brickwork assume that they have little in common? There is no more reason for insularity here than for hostility between engineer and fireman on the locomotive or for cross-purposes between the army and the navy.

If a turbine breaks down at a critical period of the load, necessitating the immediate attention of the turbine-room force, and additional assistance is needed from the fireroom, no matter for what purpose, let it be cheerfully rendered. "I wasn't hired to do this!" is one of the most miserable points of view that a human being can take in facing an emergency call on his services. It is as good a recipe for staying in the mediocre class as can be quoted, and puts a man in a group of which he should be ashamed to be a member.

Diametrically opposed to this attitude is the cooperative spirit shown by the chief when, in a critical time, he strips off his coat and vest and "mobilizes" every ounce of ability and strength he possesses at the scene of trouble; of the construction superintendent who doesn't hesitate to go into a manhole with a dress suit on in order to clear up trouble for which he is ultimately responsible and which is costing his company a month's salary every hour that service is interrupted; and of the assistant engineer who doesn't balk at coal passing for a quarter-hour in case the regular force is overloaded through the sudden illness of one of its members on the job.

The operating records and the atmosphere of friendly collective effort in many plants bear witness to the team work therein. Much of this cooperation never gets into the log sheet and is known to only two or three men most immediately affected. It counts on the unit costs, however; and important as it is to define the responsibilities of individuals, it is wise not to attempt to limit their range of mutual helpfulness.

The smaller the station, the more give and take there naturally is between the operating men on duty; but even in the larger plants there is room for the practice of a personal "readiness-to-serve," which goes a long way toward maintaining good records in station performance.

Contributed by H. S. KNOWLTON, *Cambridge, Mass.*

Operation and Maintenance of Elevators—Winding-Drum Machines

By R. H. WHITEHEAD

The various parts of a modern winding-drum-type elevator machine and their function are described. Two classes of machines are considered; namely, those located overhead and those installed in the basement or on a lower floor.

A COMPLETE installation, using the winding-drum type of elevator machine, is shown in Figs. 1 and 2. In Fig. 1 the machine is set on overhead beams at the top of the hoistway; in Fig. 2 on a concrete foundation in the basement or lower floor. The particular feature that characterizes this type of installation is the spirally grooved drum *D* which winds or unwinds the ropes to the car *C* and to the drum counterweight *DW*. When raising the car, the car ropes are wound up on the drum and at the same time the ropes to the drum counterweight unwind, thus lowering the latter. In this manner the weight of the car and the load in the car are partly counterbalanced by the drum counterweight.

Besides the foregoing method of counterbalancing, in some cases, as in the illustrations, a car counterweight *CW* is provided, the ropes for which lead directly from the car to an overhead sheave *S* or sheaves, as the case may be, and thence to this separate counterweight. This, of course, takes a certain amount of load from the car ropes leading to the drum and thereby makes it possible to handle a heavier load than would be the case otherwise. The amount of counterbalancing and its distribution between the car counterweight and the drum counterweight depend on the speed, load and service of the elevator. The counterweights are carefully adjusted by the elevator manufacturers to secure the most economical results for the particular condition, when the installation is first made. However, the car counterweight under any condition must be less than the weight of the empty car, and the total amount of counterweight is generally equal to the weight of the car plus 25 to 40 per cent. of the speed load.

Arrangement of Counterweights

As shown in Figs. 1 and 2, the car counterweights and drum counterweights both run in the same set of hoistway guide rails *HG*. They are entirely independent, however, the weights for each being contained in separate frames. It is necessary to slot or recess the weights in the top or car-counterweight frame so as to permit the passage of the ropes to the bottom or drum-counterweight frame and to slot the ends of the top and bottom frame weights in each frame to engage the guide rails. The drum counterweights are placed in the bottom frames and the car counterweights in the top, and the ropes are adjusted so that the frames are about six inches apart. This arrangement is necessary in order to prevent the addition of the drum counterweight to the car counterweight in the event of the possible breaking of the drum-counterweight ropes, as under this condition the car with a light load would be seriously overbalanced.

Where the drum-counterweight ropes pass through the car counterweight, they are inclosed in steel tubes to prevent abrasion as there is a small difference in the relative movement of the two sets of counterweights when starting and stopping the car. An adjustment of the rope lengths should always be maintained so that the weights bottom before the car strikes the overhead work and so that the car fully compresses the spring bumpers *B* shown in the pit at the bottom of the hatchway, Fig. 1, before the counterweights come in contact with the overhead work. Allowances should be made for a sufficient margin of overtravel to take care of the inertia of the machine and weights.

Counterweight Compensation

In Fig. 1 a chain *H* is shown attached to the bottom of the car and the drum-counterweight frame. As the car rises in the hoistway, the ropes to the overhead work become shorter and the ropes from the overhead work to the weights become longer, with the result that the weight of the ropes on the car side becomes less and increases on the counterweight side. This produces a constantly changing amount of counterbalance for which it may be advisable to provide compensation. Where the rise is less than 150 ft., the unbalancing of the ropes makes little difference, but for higher rises it is advisable to provide a chain counterbalance, as shown in the figure, which neutralizes this shifting of the rope weight and keeps the counterbalance constant, thus saving in the power consumption of the elevator. Where chain counterbalance is provided, the links of the chain are generally interwoven with sash cord to eliminate noise.

The elevator cab shown is set in a steel frame or "sling." This sling consists of top channels *F* forming a crosshead, two bottom channels forming the safety plank *P*, upright channels *U*, called stiles, connecting the crosshead and safety plank with a platform mounted on the latter and braced to the stiles with tension braces *TB*. Gusset-plate bracing *G* is shown between the crosshead and stiles. The car and car-counterweight ropes connect by thimbles to the center of the crosshead. At the ends of the crosshead channels and safety plank are the adjustable-spring guide shoes *A*, which are slotted and fitted with gibs to engage the main guide rails *M* in the hoistway. The guide shoes are each attached to a stem inserted in a holder and held by a bracket on the crosshead and safety plank. The shoes are arranged so as to have limited movement, backed by spring pressure which keeps them securely against the rails.

Figs. 1 and 2 both show a ball governor *E* located overhead. The rope operating this governor passes around a tension sheave *N* at the bottom of the hoistway, Fig. 2, and is connected to a device *J* on the car that actuates the safety. If the car overspeeds when moving in a downward direction, as would occur if the

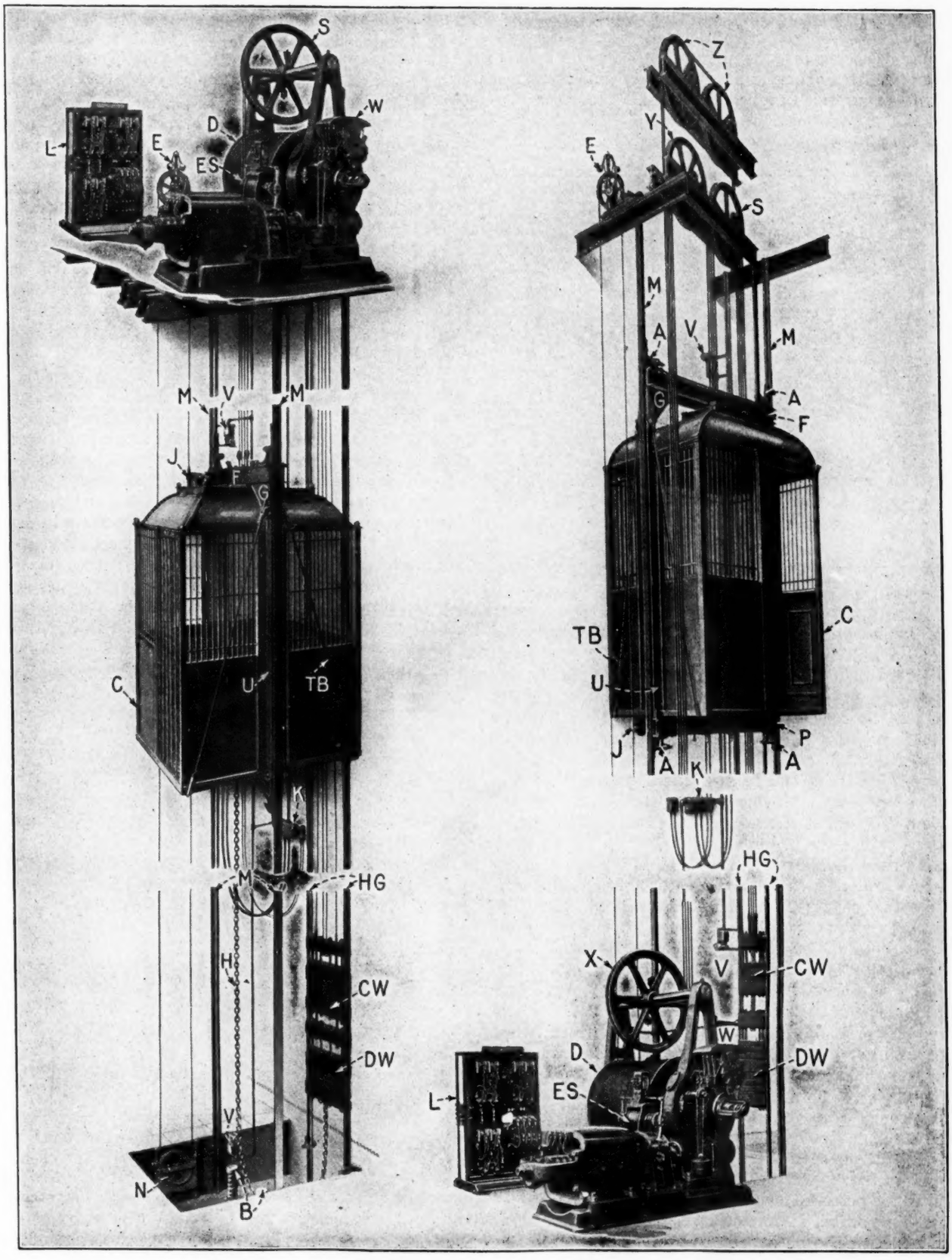


FIG. 1. WINDING-DRUM-TYPE ELEVATOR MACHINE: OVERHEAD INSTALLATION

FIG 2 WINDING-DRUM-TYPE ELEVATOR MACHINE: BASEMENT INSTALLATION

car ropes parted, the balls on the governor spread sufficiently to throw the governor jaws and hold the governor rope fast. This operation sets the car safety gripping device against the main guide rails and stops the car. A later article will describe in detail the various types of safeties and their operation.

Each of the installations shown in Figs. 1 and 2 is of the car-switch-control, single-speed type. The flexible

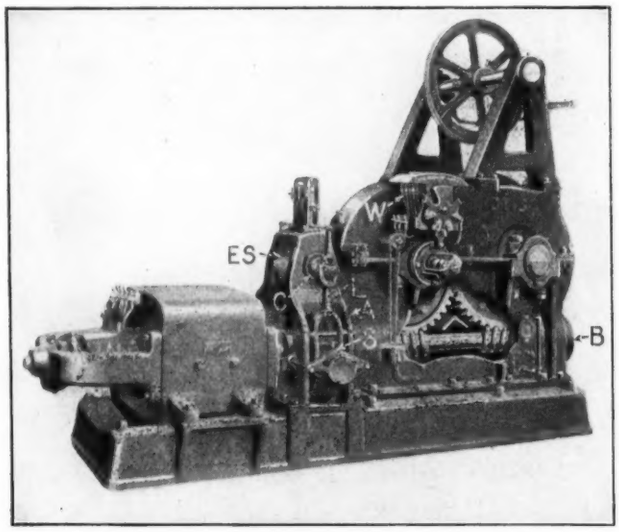


FIG. 3. DOUBLE-SCREW ELEVATOR MACHINE

cables containing the wires of the control circuits lead from the bottom of the car to the junction boxes *K* in the hoistway and are used for the operation of the controller by the car switch, for the light in the car and for the floor-signal system. The controllers *L* shown are arranged for direct current. Later articles will deal with various types of both alternating- and direct-current elevator controllers. In the present case each controller has a main-line or potential switch, "up" and "down" direction switches and an accelerating switch which brings the motor automatically up to full speed at a rate depending upon the load. A movement of the car-controlling switch toward the car-door opening energizes the magnet of the down-direction switch. This magnet closes the switch, which simultaneously lifts the brake shoes and connects the motor to the line so that it rotates in the proper direction to lower the car. Similarly, a movement of the car switch away from the door opening energizes the magnet of the up-direction switch. In the car a safety switch is provided which, when opened in case of emergency, interrupts the circuit of the potential-switch magnet, and this in turn interrupts the current to the direction switches and stops the car.

Hoistway limit switches *V* are provided at the top and bottom of the hoistway. A cam mounted on the side of the car engages these limit switches after the car overruns the top- or bottom-terminal landing. This also causes the potential switch on the controller to open. A slack-rope switch is provided which opens the potentia switch when the hoisting ropes become slack for any reason. In the case of an overhead machine this switch is mounted on the car crosshead and connected to the car ropes. For a machine in the basement or on the lower floor, the slack-rope switch is located on the bedplate under the hoisting drum. In either case, when the ropes become slack, as they would when the car safety operates or when the car runs down onto the bumpers in the pit, the amount of slack is prevented from increasing by stopping the motor. The slack must be removed and the ropes properly placed on the drum before the car is again started.

The hoisting machines are provided with an automatic switch *W*, shown in the figures on the right-hand side of each machine. This switch is adjustable and is set so that the car will run only a short distance past the top and bottom landings, if the elevator operator neglects to center the car-controlling switch. The automatic switch first causes the direction switch on the controller to open, corresponding to the direction of car travel, and the brake to set; a further movement of the car opens the hoistway limit switch *V*, and a still further movement causes the automatic switch *W* to open the main-line circuit to the motor.

It will be noticed that each machine has attached a sheave, *S* Fig. 1 and *X* Fig. 2, arranged to move along a shaft parallel with the drum. This sheave is known as an "attached vibrator," the sheave moving or vibrating back and forth along the shaft so as to maintain a proper lead on the ropes as they wind or unwind on the drum. Frequently, vibrator sheaves and shafts are detached from the machines and they are then termed "detached vibrators." In the case of a machine located in the basement or lower floors, as in Fig. 2, the attached vibrator is used for the drum-counterweight ropes and the vibrator sheave must move along the shaft as the ropes wind and unwind on the drum. For machines located overhead, as in Fig. 1, the attached vibrator is used for the car-counterweight ropes and does not move

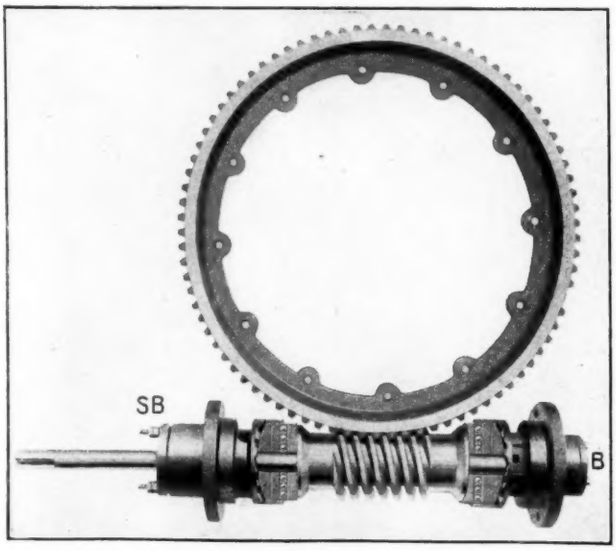


FIG. 4. SINGLE WORM AND GEAR, SHOWING BALL-THRUST BEARINGS

along the shaft although it is still called an "attached vibrator." Frequently two or three vibrator sheaves rotate on the same shaft, depending on the particular characteristics of the layout.

The sheaves shown overhead in Fig. 2 are termed the "overhead sheaves." Where there are two in the same horizontal plane for one set of ropes, as shown at *Z*, they are called "tandem sheaves." Sheaves *Z*, Fig. 2.

are used for the drum-counterweight ropes and sheave *Y* for the car-hoisting ropes.

The drum and worm-wheel spiders of the machine are keyed to the drum shaft. This shaft is provided with marine or collared bearings mounted in the outboard-end stand and in the wormwheel casing. This type of bearing is required so as to resist the side thrust of the wormwheel. The worm shaft is provided with an outboard bearing *B* in the gear case and passes through a stuffing-box *SB* on the inboard bearing of the case, Figs. 3 and 4. The motor shaft and worm shaft are connected with a coupling which is also used for the brake drum. The brake *A*, Fig. 3, is operated with an electric solenoid *ES* which, when energized, pulls the solenoid cores together. The cores *C* are attached to a link motion *L*, which lifts the brake shoes off the brake drum, the lifting being opposed by springs at *S*. When the circuit of the solenoid is open, these springs apply the shoes to the brake drum, and if properly adjusted, the car is smoothly brought to rest at all loads. This stopping distance is called the slide and varies with the car speed and load.

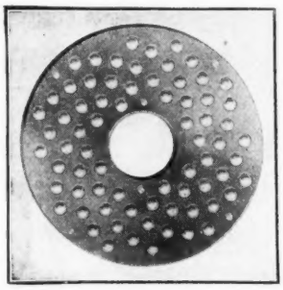


FIG. 5. THRUST-BEARING BALL PLATE

The outboard drum-bearing stand, gear case, brake stand and motor are all bolted to a cast-iron bedplate. This bedplate must be rigidly supported in place and the alignment of the motor shaft and worm shaft carefully checked after the load of the car and counterweight are on the drum before coupling them together.

Drum-winding machines are either of the single-screw type, shown in Figs. 1 and 2, or the double-screw type, as shown in Fig. 3. In the single-screw type, the thrust between the worm and wheel is taken on a ball thrust bearing. The details of the worm and wheel, thrust and worm shaft bearings are clearly shown in Fig. 4. Fig. 5 shows a thrust-bearing ball plate; note the spiral arrangement of the balls to evenly distribute the wear. In the double-screw type of machine, Fig. 3, no thrust bearings for the worm shaft are required as a right and a left worm on the same shaft as part of the same forging engage a right and a left wormwheel, which in turn are also cut to mesh together as spiral gears, thus giving a three-point drive. The outboard wormwheel is attached to the drum shaft. The worms may be single, double or triple threaded in either single- or double-screw machines, depending on the car speed desired.

Ventilated Side Walls

BY WILLIAM R. CATON

One source of annoyance to all stoker operators is the tendency of clinkers to stick to the side-walls, cutting down the available grate area and badly injuring the brick when cleaning fires. By the constant breaking away of brick that are melted into clinkers, the side-walls need frequent repairs. After a number of years of repairing brickwork in furnaces, Ernest Bernitz tried the method of ventilating the side- and bridge-walls shown in the accompanying illustrations.

Fig. 1 shows the furnace walls with Riley stoker. A hole five or six inches square is built in the wall below the grate and connecting air chamber under the grate with the $1\frac{1}{2}$- or 2-in. pocket built in the side-

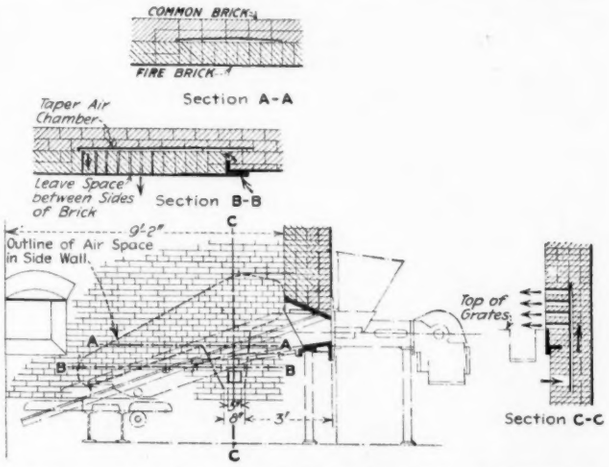


FIG. 1. SIDE-WALL AIR OPENINGS, RILEY STOKERS

wall. Above the grates for three, four or five courses, depending on what capacity boiler is to be worked, headers are laid without fireclay between side joints, which allows air from the air chamber to go to the side-wall pocket, then through the narrow apertures between the brick, keeping the brick cool and preventing clinker sticking to them. Fig. 2 shows the side-wall built with Taylor stokers. The brickwork or

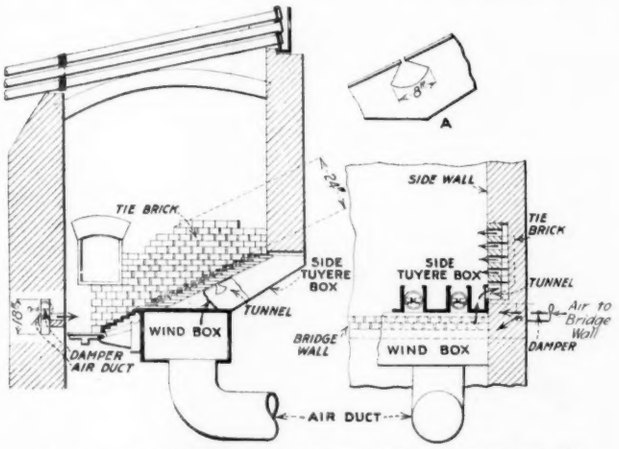
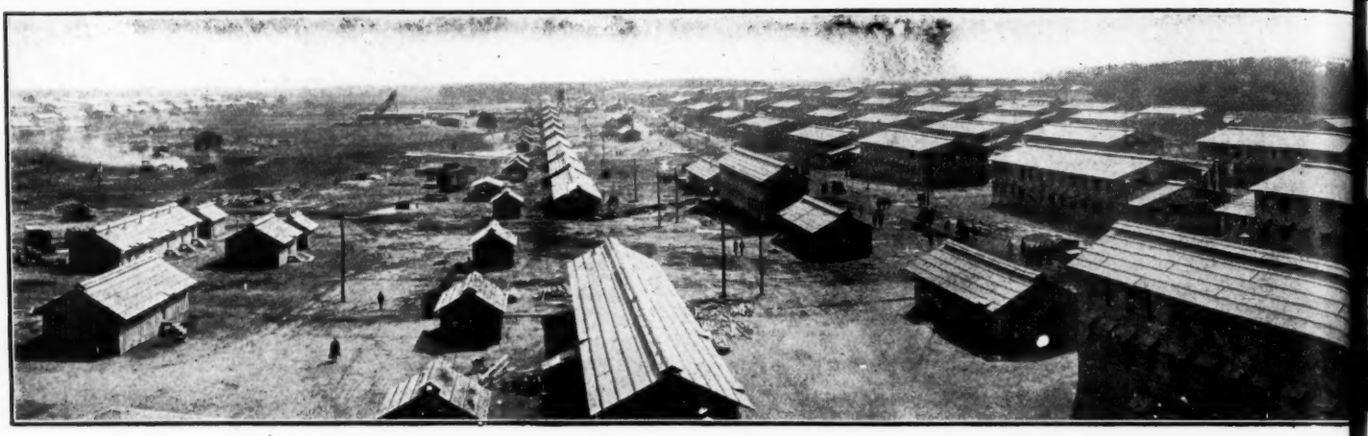


FIG. 2. SIDE-WALL AIR OPENINGS AS APPLIED TO TAYLOR STOKER

setting with Taylor stoker is similar to that with the Riley, but to connect it for ventilation necessitates cutting a V-shaped hole through the cast-iron wind-box under the tuyere irons.

This scheme of ventilating was tried with hand fires and natural draft many years ago, but never proved successful enough to warrant a patent on it. With forced draft it is a success, either with stokers or hand fires.

Delivery of equipment these days is as slow as that lack of speed expressed by the English cabby to his American charge who protested at the cockney's delay: "'S all right; you kept us waitin' three years."



Camp Dix Military Cantonment

THE photographs reproduced show in a general way the progress made in preparation for the mobilization of the new American Army at Camp Dix during the period from July 17, when the picture at the top of the page was taken, to Oct. 13, when the one next below was taken. The artillery section may be seen in the distance in the upper left-hand corner of this picture. The picture at the bottom of the opposite page gives a better view of some of the officers' quarters and a part of one of the drill grounds.

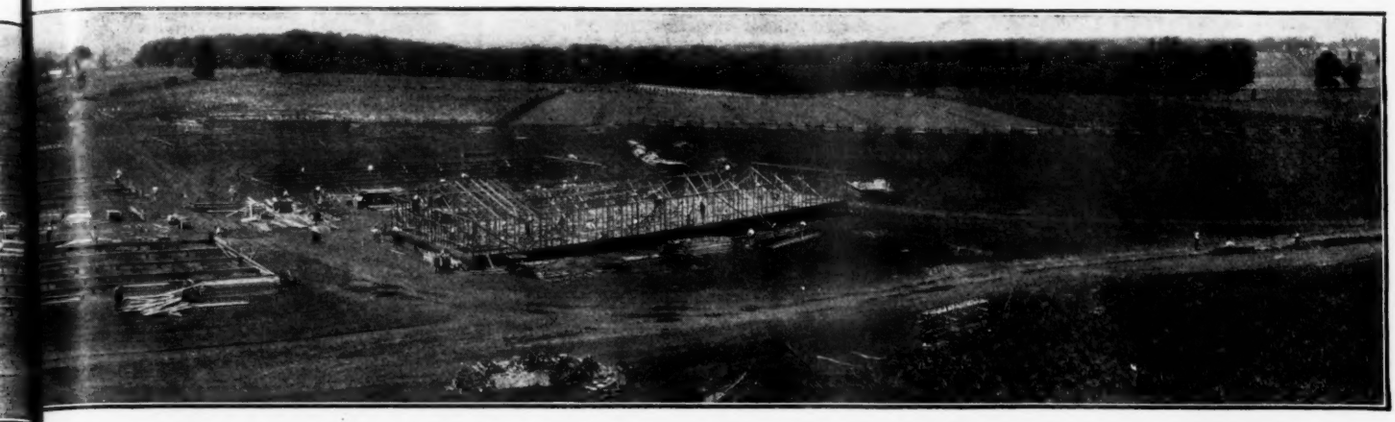
The building construction almost throughout is of the double-siding and double-floor type, with felt or tar paper between and tar-felt roofing, making at once inexpensive, easily built and warm buildings. Hand labor in all operations was reduced to a minimum. Semi-portable sawtables, driven by small gasoline engines mounted beneath, were much in evidence.

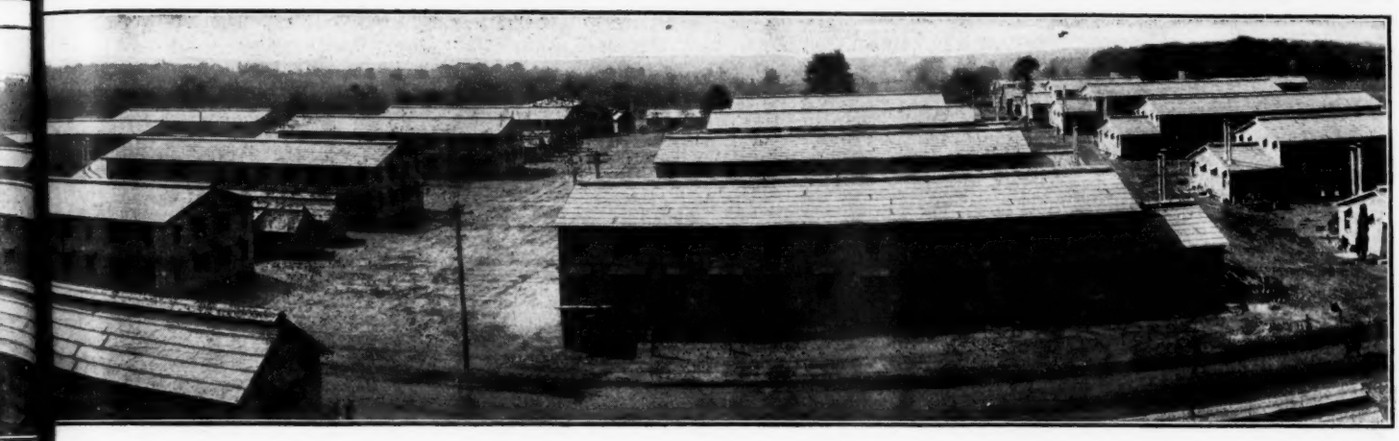
Road building constitutes an important element in all military operations and is one of the first engineering enterprises of any camp. Clamshell buckets were used for unloading road-making and like material from the railway cars wherever possible, and self-dumping motor trucks were used for distribution within the grounds.

The barracks generally are two-story frame buildings 43 ft. wide by 140 ft. long, with a one-story "cook shop" at one end, and each is designed as sleeping quarters and mess for about 175 men. They are heated by two large heaters on each floor. The officers' quarters are small one-story buildings, 20 ft. wide with an average length of 112 ft. divided into living quarters, offices and kitchen, so that heating by stoves is not practicable.

A small cast-iron sectional steam boiler is located in a pit at the rear of the building, and a loop of piping runs under the floor with short risers through the floor to the radiators—an arrangement at once as simple and "foolproof" as seems possible to design. The camp is provided with a complete system of roads, sewerage, water supply and fire protection, telephone communication and electric service. Standardization in design is thoroughly carried out.

The base hospital group of buildings is located at a considerable distance from the barracks. This is the only group supplied by a central heating plant. The boiler plant consists of a battery of eight boilers rated at 150 hp. each, seven of which are to operate at low pressure for heating direct and one at high pressure for the kitchen and other uses where a continuous high-pressure steam service is needed. Hot water is supplied through a 2½-in. flow and return line from a large storage tank containing a steam coil. The low-pressure boilers are fed by the "service main" pressure and the high-pressure by means of a feed pump. The boilers are hand-fired and each has an independent stack 33 in. diameter. The piping system is divided into two sections, but cross connections are provided at several points for use in case of emergency, expansion bends and loops are used on the 10- and 8-in. lines and slip expansion joints on all smaller sizes. The wards are piped independently with the "drainage slope" toward the extreme end where the condensate is discharged through a trap. The total radiation in the hospital group is upward of 90,000 sq.ft. The main distributing





Near Wrightstown, New Jersey

lines are of approximately the following size and lengths: 1150 ft. of 10-in., 1300 ft. 8-in., 1600 ft. 6-in., 1800 ft. 4-in. and 2200 ft. of 3-in. pipe.

The camp is supplied with ice from an electrically driven ice plant in a section of the grounds convenient to the railway, where meats and other perishable commissary supplies are received and distributed. By courtesy of Capt. H. A. Gilbert access to all proper data was given to a representative of *Power*. The photographs were supplied by W. N. Jennings, 1305 Arch St., Philadelphia, Penn., the official photographer for the contractors, Irwin & Leighton.

OFFICERS' QUARTERS AND PART OF ONE OF THE DRILL GROUNDS

Methods of Drying Out Flooded Power Plant Equipment

By NORMAN L. REA
Construction Engineer, General Electric Co

Various schemes that may be employed for drying out electrical equipment after a power plant has been flooded are discussed. The advantages and disadvantages of the various methods are pointed out.

FLOODS are no respecters of power houses, and the majority of troublemen have to clean up the mess left by one of them sooner or later. Of course the old adage, "Many men of many minds," applies in this work as in everything else, and countless schemes have been tried with all degrees of success. In fact, some of the schemes have made matters worse instead of better. Possibly a brief outline of a few good ways and a caution regarding some of the bad ones may be of assistance to some brother in distress.

A power house after a flood is a sorry sight—oil and river silt smeared over everything and unlimited driftwood and sand everywhere. The first thing of course, is a thorough cleaning, and this should be started immediately and carried on while stock is being taken of the local facilities and a plan of campaign laid out. The machines should be thoroughly washed with water under pressure (a fire hose works very nicely), and all bright parts dried and oiled to prevent rusting. The bearings should also have immediate attention to prevent rusting. They should be thoroughly cleaned of all dirt and grit, dried and oiled before rust gets a foothold.

Run Machine To Assist in the Drying

Just as soon as the machines can be turned over, they should be brought up to speed and run without field as the windage will assist materially in the drying. The building should also be cleaned and heated to drive out the dampness. This heating will also assist considerably in drying the machines. Special care should be taken to ventilate the power station so that the damp warm air may be replaced by dry air.

In an alternating-current station the exciters should, of course, have the first attention, although the alternators should be run on windage while the exciters are drying. Small exciters have been dried out by windage and a plumber's furnace under the commutator. Care should be taken not to get the commutator too hot.

The machines may also be baked in a temporary oven or hot air blown through them. One must remember, however, that heat alone will not do the trick. The moisture must be removed, and nothing else will carry away moisture like hot, dry air.

In many cases machines have been surrounded with steam radiators and carefully covered with several thicknesses of tarpaulins. After several days of this "drying," those in charge of the job were greatly surprised to find the insulation resistance considerably lower than when the work was started. Steaming is all right for clams, but is poor treatment for water-soaked insulation. A little planning and a few bafflers will usually cause the hot air from the radiators to flow through the machine by its natural draft. Hot air may be forced through the machine by a blower when power is available. The foregoing methods are good when it is impossible to run the machines owing to lack of mechanical power, or in the case of synchronous motors. It is especially applicable to exciters. Of course the machine should be run if at all possible, and the heating arranged so that the natural windage will assist the hot-air circulation. The heat may be supplied by steam radiators, hot-air furnaces, stoves, electric heaters or lamp banks.

No two jobs are alike, and there is an excellent chance for a man to show his ingenuity and skill in the best use of local resources. An open flame should not be used. In one case where coke fires were used with a blower, the coke dust, ashes and fumes were blown into the windings. After several days' treatment, the windings showed a lower insulation resistance than when the drying was started. This was apparently due to the dust lodging in the windings, and the fumes may have caused copper corrosion.

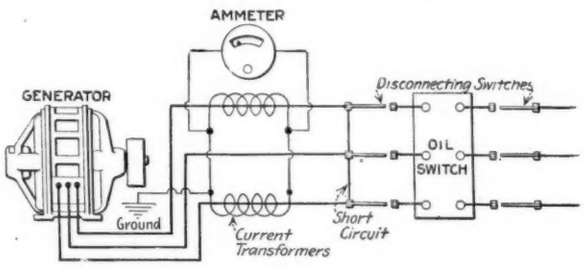


FIG. 1. CONNECTIONS FOR SHORT-CIRCUIT HEAT RUN ON ALTERNATING-CURRENT GENERATORS

The temperature of the hot air with any arrangement should not be higher than 100 deg. C., and 80 deg. C. is a safer temperature, because some insulating compounds change at fairly low temperatures. The fire risk must always be kept in mind and excessive temperatures avoided.

As soon as an exciter is dry enough or direct current is available from any source, all the alternating-current generators should be put on a short-circuit heat run. This is done by short-circuiting all phases through the proper size current transformers and ammeter, as shown in Fig. 1, and applying a weak field, which is increased slowly until the armature winding is carrying full-load current. Generators with an overload rating may be run with this overload current. However, many machines are now given a maximum rating, and any current in excess of this rating may damage the windings. The short-circuit of the generators should be made between the generator and the oil switch as in the figure, or the oil switch blocked in the closed

position and the load handled by the field current exclusively, because opening the armature circuit during the short-circuit run is quite likely to puncture the wet insulation.

The short-circuit heat run should be continued until the insulation resistance reaches a proper value. This resistance will, of course, vary with the size of the ma-

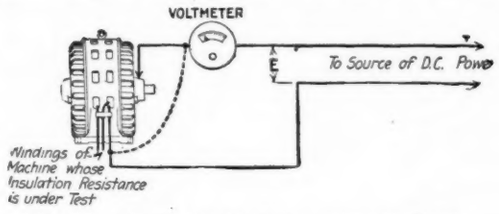


FIG. 2. INSULATION-TEST CONNECTIONS

chine, kind of insulation, voltage, etc. In general the insulation resistance indicates little more than the condition of the insulation as regards moisture. The rate of change of the resistance as the heat run progresses is, perhaps, the best indication as to when the drying has been carried far enough. The drier the insulation becomes the slower the insulation resistance will increase. Judgment must be used in deciding when it is safe to stop the short-circuit run.

In many cases a Wheatstone bridge or megger is not available for measuring the insulation resistance. The following method will give results accurate enough for general use: Connect one side of a direct-current circuit to the windings to be tested, connect the other side of this circuit to a portable voltmeter, and then read the voltage when the free side of the voltmeter is connected to the circuit where it is attached to the windings, as indicated by the dotted line, Fig. 2. Call this reading E. Then connect the free side of the voltmeter to to the frame of the machine, as shown in full lines in the figure, being careful to get a good contact, and call this reading E_1. Then the insulation resistance $R = \frac{R_1(E - E_1)}{E_1}$, where R equals the insulation resistance and R_1 the resistance of the voltmeter; the latter value is usually given inside the meter cover.

Before using any commercial circuit for insulation testing, voltmeter tests must be made to determine if the circuit is grounded. One side of the circuit must be free from grounds, and the ungrounded side used in series with the voltmeter when testing. Failure to test for grounds has led to short-circuits and personal injuries.

After the short-circuit test is ended, the machines should be brought up to normal voltage slowly and should be inspected very carefully while the voltage is building up. Incipient breakdowns can usually be seen, heard or smelled and the field circuit opened before the windings or punchings are materially damaged. One man should stand by the field switch to open it instantly on signal from the men watching the machines.

The machine should be run several hours at normal voltage or 10 per cent. above normal to heat the iron thoroughly before going into regular service. It is advisable to continue the drying of very large generators 24 hours longer as follows: Two hours at full-load current on short-circuit, then two hours 10 per cent. above normal voltage open-circuit. These alternating runs heat both the iron and the windings thoroughly and drive out any remaining moisture.

There is always a tendency to hurry the machines into service, and great pressure is usually brought to bear on the man in charge of the drying. It is imperative to "make haste slowly," as a day or two longer drying is a lot better than a burned-out machine with the consequent delay and expense.

Large direct-current machines that have been submerged usually give the most trouble in the commutator, especially if the machines are flooded when hot. Apparently the sudden cooling causes a partial vacuum under the commutator bars and some water is drawn into this space. The heating of the commutator causes expansion which traps this water. Consequently, the machine responds very slowly to direct heat on the commutator or short-circuit heat runs, unless some exit is provided for the moisture. The following scheme has produced excellent results on several occasions.

Every other bolt is removed from the outside clamping flange of the commutator. Then some small bent funnels were made, shaped like a ship's ventilator hood, as shown in Fig. 3 at *A*. One of these air scoops was fastened in every other hole and faced in the direction of rotation as in the figure. The ventilating funnels were made up by a local tinsmith and twisted into the holes, after which no trouble was experienced by their coming out. Of course all of them were used on fairly slow-speed machines, and as the funnels were down near the shaft, they did not move very fast. The machine must be run at reduced speed, to prevent injury to the commutator. The scoops force air through the space under the commutator bars and out the other holes, materially hastening the drying. In some cases one can actually see the vapor coming from the open holes.

There are several ways of heating direct-current machines. The various methods of drying with hot air, previously outlined, can, of course, be applied when the machine cannot be run or there is no outside power

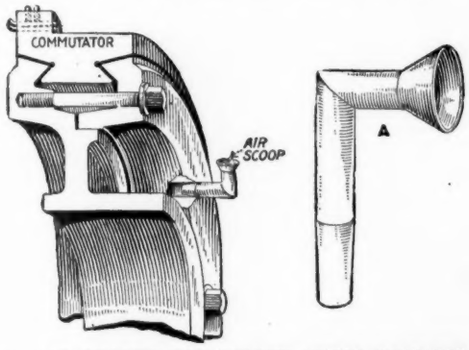


FIG. 3. AIR SCOOPS FOR VENTILATING COMMUTATOR

available. The simplest, when the machine can be run and direct current is available, is a short-circuited heat run. The series field should be reversed to buck the shunt coils and the armature short-circuited through an ammeter and a circuit-breaker or fuse.

Then a very small current is sent through the shunt field and gradually increased until full-load current flows through the short-circuit. Extreme care must be used in first throwing on the short-circuit, for unless the series-field windings are bucking the shunt, the machine will pick up as a series generator on short-circuit, with

surprising and sometimes disastrous results. Unless the circuit-breaker can be set very low, it is advisable to connect a small fuse in the circuit for the first trial.

In some cases the brushes may need shifting forward from the regular running positions so that the resulting sparking will increase the heating of the commutator.

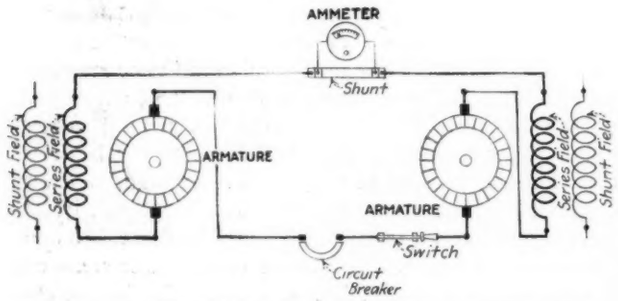


FIG. 4. CONNECTIONS FOR HEAT RUN ON TWO COMPOUND-WOUND DIRECT-CURRENT GENERATORS

This should not be carried far enough to spoil the commutator's surface and make turning or grinding necessary.

Where no exciting current was available on a job involving two large engine-driven machines—after considerable study the following scheme was used with excellent results: The series field of one machine was bucked so that it opposed the tendency to pick up as a series generator, then the two machines were connected in series through an ammeter shunt and circuit-breaker. Both machines were equipped with air scoops on the commutator end flange. The machine with the bucked field was brought up to half-speed. Then the other machine was turned over slowly and the speed gradually increased until full-load current was flowing through the combination. This required about 20 per cent. of normal speed for the generator. Fig. 4 shows the scheme of connections used. Both shunt-field windings were left open, as there was no way of exciting them.

Sometimes the commutator heating can be materially assisted by one or two plumber's furnaces turned low and placed with their tops a foot or two below the commutator. Care should be taken not to heat the commutator too quickly or too hot. Most commutators are pressed on an extension of the armature spider hub, and the pressing fit allowance is usually small. Too rapid heating may, therefore, expand the commutator enough to loosen it on the shaft. In fact, this was first discovered by a commutator starting to walk off its seat. Fortunately, this was noticed before any damage resulted, and the heat run was discontinued while it was jacked back to its proper place. The windings should not be heated over 100 deg. C., although the commutator will safely stand temperatures above 100 deg. C. "It is better, however, to be safe than sorry," therefore, use 80 deg. C. as a maximum on the windings and 100 deg. on the commutator. These values are actual temperatures and not a rise above the room temperature.

The drying should be continued until the insulation resistance reaches a safe value and the machine then brought up to normal voltage very slowly. The remarks under alternating-current generator drying apply equally well to direct-current machines, except that it is unnecessary to alternate the open and short-circuit runs.

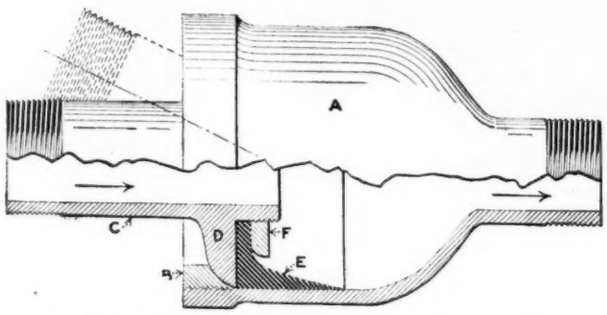
The insulation resistance is usually considerably lower than the alternators, but the drying takes about the same length of time, especially if water gets into the commutator.

Berry Flexible Joint

Various arrangements are used in pipe-line construction to provide for expansion and contraction and to release the pipes from strain, jarring and vibration. Expansion bends, swing joints, unions and sundry types of flexible joints are used for this purpose. Included in the line of flexible connections is the new Berry flexible joint, manufactured by the Iron Clad Joint Co., 400 Godchaux Building, New Orleans, La. It is arranged for use with steam, air or water, and is illustrated herewith.

This is not a metal-ball joint, but it has the action of one, and it is designed to take care of vibration, expansion and contraction. It is so flexible that it can be swung automatically in any direction and always leave a full and unobstructed area to the flow of liquid or gas.

The device consists of six parts, as shown. The shell, or bell end, *A* is threaded on the inside for a bearing



SEMI-SECTIONAL VIEW OF THE FLEXIBLE JOINT

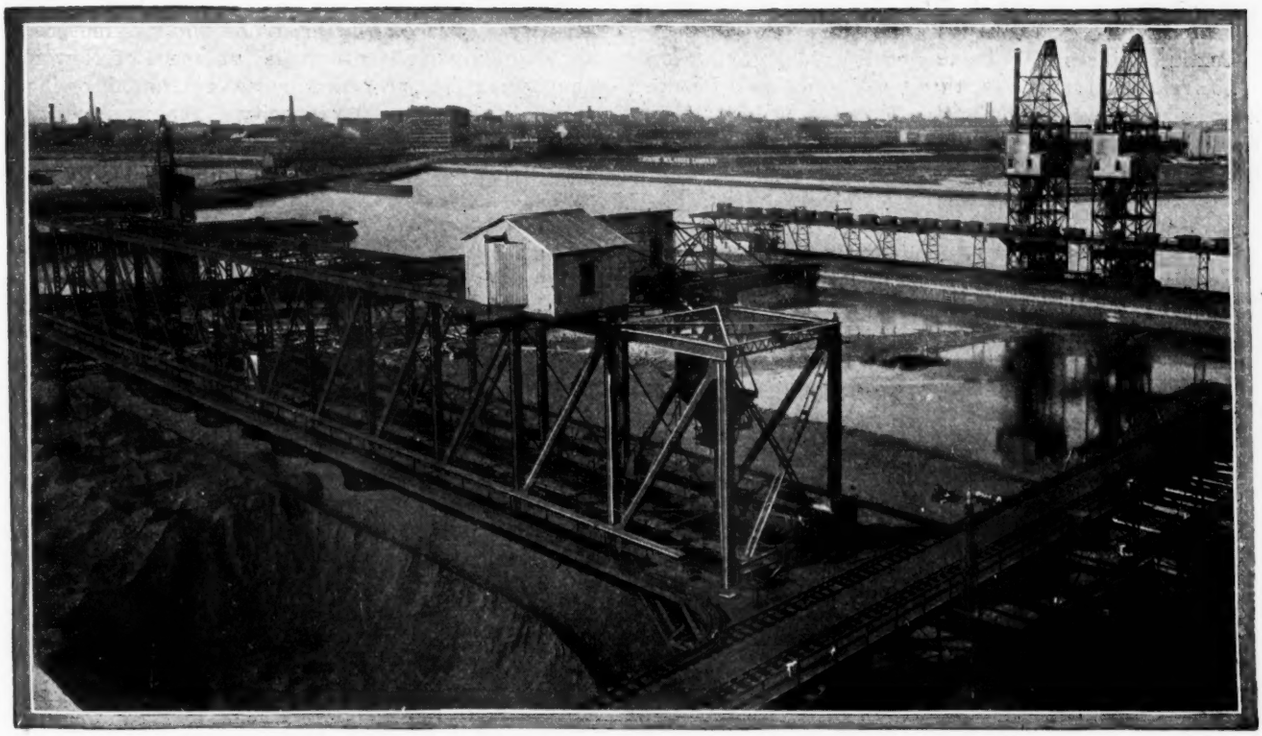
ring. The pipe *C*, forming the other pipe connection, is made with a flange *D* with a machined curved surface on the side that has a bearing with the ring *B*. The flange is made flat on the opposite side, so that the cup-shaped flexible member *E* has a flat surface against which it is firmly pressed by the ring *F* when screwed up on the thread on the inner end of the connection *C*.

With the pressure entering the joint in the direction of the arrows, the flexible member *E* is forced out against the inside surface of the body *A*, making a steam-tight joint regardless of the angle in which the connection *C* may be.

The Salt Lake *Tribune* recently published the following:

> Consent was voted yesterday morning by the City Commission for the Utah Power and Light Co. to drain condensed water from its heating system into the sewer. It was explained to the commission that distilled water that returns from the steam pipes is injurious to the boilers if returned to them because of its activity as a solvent.

Nothing like reading the newspapers for getting valuable engineering information—some engineers don't know about this.—*W. E. Jacob.*



Relief for New England Coal Situation

By CHARLES H. BROMLEY

Governor McCall of Massachusetts, together with Fuel Administrator Storrow and other governors and senators from New England, visit Washington to force relief for coal situation. Railroads and trolley-car service reduced to avoid immediate depletion of supply. Navy responsible for serious withdrawal of large-towing capacity. New England short nearly 8,000,000 tons of bituminous coal on January First.

NEW England's coal situation was never more acute. And there is the devil to pay about it, as Washington learned last week. Fuel Administrator Storrow and Governor McCall of Massachusetts, accompanied by other governors and senators from New England, visited the capital to force immediate action to relieve the grave fuel condition of the six Northeastern States. The outlook therefore is brighter, though it should be understood by fuel users that a shortage of the most severe kind cannot now be avoided; nevertheless it will be of shorter duration than it would have been but for the impressive visit of the New England delegation to Mr. Garfield at Washington. Governor McCall was not sparing in his condemnation of those responsible for New England's plight. The Navy Department particularly was censured by the Governor for its too wholesale commandeering of ocean tugs, leaving a shortage of power craft to tow loaded coal barges from Hampton Roads to New England ports. This is what the Governor had to say: "The Secretary of the Navy is said to have proudly declared before a committee of Congress the other day that we have a thousand ships in the Navy; but if those ships, according to tonnage, could begin to inflict the damage on the Germans that the withdrawal of coal tugs, according to their tonnage, has inflicted on the northeastern part of our own country, it is doubtful if the Germans would last a week."

One effect of the Governor's visit will, it is promised, be the stopping of cross-hauling; that is, no coal trains shall pass each other running in opposite directions. The Chesapeake & Ohio R.R. is to haul coal from the mines to Hampton Roads for New England delivery.

It is charged that while coal shortage is due to rail-transportation difficulties chiefly, the roads would have three-thousand locomotives for coal hauling if the locomotive shops had not been commandeered for the building of locomotives for Russia and France.

Capt. Arthur Crowley, who is the marine representative of the New England Fuel Administration, is confident of improvement in towing capacity for barges to New England ports. The Navy took one-fourth of the towing capacity of the Reading road used in the New England trade, and the ten tugs taken from the towing service between Hampton Roads and New England have left a shortage of such capacity amounting to many hundreds of thousands of tons per year. Much of this will likely be restored as the result of the efforts of Fuel Administrator Storrow.

There is serious congestion at Hampton Roads. The Boston Elevated Railroad Co.'s chartered steamer "Everett" has been, at this writing, riding at anchor for eight days awaiting opportunity to load, which she can do in eight hours. Her capacity is 7200 tons. To facilitate coal leaving Hampton Roads, ships may now

pass in and out of the harbor at any time, day or night. The Boston & Maine R.R., according to President Hustis, requires 5000 tons of coal per day for its locomotives; but for the last thirty days only 2000 tons per day was received. The Boston Elevated system and the Bay State railways also must greatly decrease service to make the coal supply go far enough to meet the urgent transportation demands. Service on many of the suburban lines will be stopped except for a few hours morning and evening. The illustration shows the coal storage plant of the Boston Elevated Railway Co.'s South Boston station.

Though Thursday and Sunday nights are the "lightless" ones in Boston, there is a very noticeable absence of non-essential illumination every night of the week. Boston certainly responds much better to the pleas of the Fuel Administrator than does New York and Chicago, particularly.

The following data, chiefly from the office of the New England Fuel Administrator, show the coal situation as it is:

RECEIPTS OF BITUMINOUS COAL FIRST TEN MONTHS, 1917

	Net Tons
All rail (for commercial and railroad use)	9,267,925
Tidewater (for commercial and railroad use)	11,376,519
Total	20,644,444
Requirements for 1917	32,574,902
If receipts for remainder of the year continued at same rate as given above for first ten months, the total receipts for New England for year 1918 will be	24,773,332
On Jan. 1, 1918, the New England shortage of bituminous will thus be	7,801,570

NEW ENGLAND RECEIPTS OF BITUMINOUS COAL, NET TONS, FOR THE FIRST TEN MONTHS, 1917

Company Coal:		
First 10 months actual, three big roads	3,168,124	
First 10 months actual, Central Vermont	5,629	
First 10 months actual, Rutland	60,447	
Total company	3,234,200	3,234,200
Commercial coal:		
First 10 months actual, three big roads	6,011,748	
First 10 months actual, Central Vermont	54,715	
First 10 months actual, Rutland	203,262	
Total commercial	6,269,725	6,269,725
Total company and commercial		9,503,925
Less exports to Canada (Sept. and Oct. est.)		236,000
Net total		9,267,925
Tidewater receipts 10 months		11,376,519
Grand total, 10 months		20,644,444
Requirements for 1917 as previously estimated		32,574,902
If receipts for last two months should equal 1/5 of first 10 months they would equal	4,128,888	
Plus 10 months' receipts	20,644,444	
Total	24,773,332	24,773,332
Shortage Jan. 1, 1918, would thus be		7,801,570

NEW ENGLAND BITUMINOUS COAL CONSUMPTION IN 1916, NET TONS *

Tidewater coal	15,665,499
All-rail coal	10,230,253
	25,895,752
Depletion of reserves	1,250,000
	27,145,752

* These tidewater figures were obtained from statistics gathered with great care at each New England port by the Boston Chamber of Commerce. The all-rail figures were reported directly to the New England Coal Committee by the New England railroads. The coal used by the New England railroads was 5,916,789, and is included in all-rail and tidewater figures.

REQUIREMENTS FOR 1917

Consumption, 1916	27,145,752	
Add 20 per cent	5,429,150	
		32,574,902

Twenty per cent. increase for 1917 over 1916 is probably low for soft coal, as the New England industries are working this year under the most intensive pressure ever known and probably to a greater extent than any other section of the country, except perhaps the steel-making districts.

New England normally carries two-thirds of its soft coal by water and one-third by rail. Owing to war conditions many of the New England coal-carrying bottoms have gone off the coast and these cannot be replaced. The already overloaded railroads of New England cannot assume added burdens. Indeed, owing to lack of motive power the capacity of these railroads will soon be cut down at least 25 per cent. by winter storms and cold weather. The capacity of the coal-carrying fleet will likewise be cut down at least 25 per cent. by winter weather. New England's coal problem is quite as much one of transportation as of securing the coal. If New England goes into January 7,500,000 tons of coal short, as the figures given indicate, this not only cannot possibly be made up, but will inevitably rapidly grow worse owing to lack of transportation facilities.

The following is from the report of the Federal Trade Commission, June 20, 1917, Senate Document No. 50: "The situation in New England is made acute because of the disruption and disorganization of barge transportation. The cost of the water haul from New York to Boston has been increased from 50c. a ton to as high as $3 a ton. From Newport News bituminous coal is paying $3.50 to $4 per net ton instead of the normal of 70 to 90c. to New England."

New England a Spot Soft-Coal Market

By long custom of the trade, New England has been preëminently a spot-coal market. The mines have been glad to sell their coal for cash to New England consumers during the summer months while other localities were less ready to buy. New England manufacturers and householders have learned the necessity of accumulating a supply of coal during the summer months owing to the inability of the rail- and water-transportation facilities to carry coal as fast as it must be burned during the winter months. Owing to its greater distance from the mines, New England is considered a less desirable market, and at times consumers have been obliged, in order to divert coal in their direction, to bid higher prices than other localities.

The situation in New England in regard to spot coal became acute as soon as the $3 tentative maximum price was put into effect by the Coal Production Committee, because consumers were prevented from bidding higher than other localities for the coal they needed, and the mines and originating railroads at the same price preferred to improve their inadequate car supply by selling coal nearer the mines and so getting their cars back sooner.

Now that the $2 price has gone into effect, the situation has grown, if possible, worse. A very large number of the New England manufacturers who are depending upon buying spot coal for their own use have been completely shut off. Most of the coal is going to fill contracts at higher prices, and if there is any balance of free coal it is being sold nearer the mines and New England today cannot buy a car of spot coal. This is the situation that needs immediate attention.

Shortage of Anthracite Coal

On the first of May shipments of anthracite were 300,000 tons short of a year ago. By the first of July shipments had increased so that the total for the six months was nearly equal to a year ago. This had not wholly relieved the situation because no coal was provided for the normal growth of 5 or 6 per cent., and

moreover, the percentage of domestic or household sizes had dropped substantially so that household coal was shorter than the gross figures would indicate; but during July and August shipments of anthracite continued to show gains over last year.

It does not appear that the anthracite situation in New England needs immediate attention, or at least that it is as grave as the soft-coal situation. Anthracite shipments to New England for the first ten months of 1917 were 10,227,010 tons; for the first ten months of 1916, 9,220,760 tons.

The industrial centers of New England are being assisted in fuel conservation as related to boiler rooms, by inspectors from the offices of the fuel administrations and by the coöperation of the local associations and sections of the engineering societies. These representatives are versed in firing methods and go into the boiler rooms to assist, if possible, in teaching firemen how to get the most out of the coal.

The President has now taken over the railroads and the steamship lines operated by the roads. The Fuel Administrator seriously contemplates "complete control of coal if the war lasts for a long while." The pity is that men in such high office do not see that it will. Likely Dr. Garfield will assume complete control, and along lines suggested in *Power* for Dec. 18, 1917, page 832, sooner than he at this writing seems to contemplate. With the roads now fully under Government control and with the more complete supervision of the coal industry by the Fuel Administrator, New England should get relief as soon as it is physically possible to do so; that is, there do not now exist any real reasons for Government failure—except the uncertain link, labor, which everyone hopes, will hold.

New England Hurt by Long Hauls

It seems certain that before relief can come to many producers of steam and power now crying for coal, the Fuel Administration must abrogate all contracts now existing between dealers, consumers and coal-mine operators. The present panicky situation is conducive to hoarding, and operators will not, of course, put out any free coal while there is opportunity for it to bring higher than Government prescribed prices. The New England Fuel Administrator truly tells how price fixing by the Government has operated to the serious disadvantage of the Northeastern States. New England, by reason of its geographical position, necessitates comparatively longer hauls at a time of extreme car shortage, which has made coal operators reluctant to accept New England's trade. But these are propitious times, and therefore this disadvantageous period is likely to be of short duration. Its very severity compels immediate alleviation to the limit of physical possibilities.

With industries vital to the war subject to interruptions on account of lack of fuel, with the railroads compelled to withdraw train after train from service for the same cause, with scores of ships, ships so very vital to the success of our arms and those of our Allies, detained for days at their ports because of empty bunkers, to say nothing of domestic suffering, who now dares to belittle the fuel shortage as did the exploiters such a short time ago who at the time knew full well the gravity of the impending crisis?

The severe effect of car shortage on loss of coal output at the mines is shown by the Geological Survey report for Dec. 29, from which the following table, condensed, is taken:

	Week Ended	Percentage of Full-Time Output Lost On Account of Car Shortage
Illinois	Dec. 8	9.1
	Dec. 15	17.0
Indiana	Dec. 8	5.4
	Dec. 15	18.4
Ohio	Dec. 8	31.7
	Dec. 15	57.1
Pennsylvania:		
Western Pennsylvania	Dec. 8	12.6
	Dec. 15	33.6
Irwin Gas	Dec. 8	14.3
	Dec. 15	28.3
Central Pennsylvania	Dec. 8	14.1
	Dec. 15	28.3
Somerset Co.	Dec. 8	36.2
	Dec. 15	52.5
West Virginia:		
Winding Gulf	Dec. 8	25.8
	Dec. 15	41.9
Panhandle	Dec. 8	20.0
	Dec. 15	24.2
Pocahontas and New River	Dec. 8	34.0
	Dec. 15	46.4
High Volatile of S. W. Va.	Dec. 8	56.9
	Dec. 15	59.9
Junior—Philippi	Dec. 8	35.6
	Dec. 15	35.7
Fairmont	Dec. 8	31.6
	Dec. 15	40.8
Cumberland—Piedmont	Dec. 8	13.7
	Dec. 15	34.9
Kentucky:		
Hazard Field	Dec. 8	35.4
	Dec. 15	65.5
Northeastern Kentucky	Dec. 8	38.4
	Dec. 15	60.9
Western Kentucky	Dec. 8	31.4
	Dec. 15	40.2
Southern Appalachian	Dec. 8	12.0
	Dec. 15	18.8
Southwestern Virginia	Dec. 8	3.0
	Dec. 15	8.2

Notice that Ohio lost 57 per cent. of its full-time output due to car shortage; Somerset County, Penn., 52.5 per cent.; Western Pennsylvania, 33 per cent.; the important fields of West Virginia 42, 24, 46, 60, 35 and 40 per cent., respectively, while the Cumberland and Kentucky fields suffered similarly.

—By Morris, in the New York "Evening Mail"

TAKING OUT THE CLINKERS

Determining Boiler Efficiency by Co_2 Analyses and Flue Temperatures

By HAYLETT O'NEILL

The author gives several charts with the aid of which the boiler efficiency may be closely approximated when the CO_2 and flue temperatures are known. The purpose of the article is to enable the engineer to obtain valuable operating data for practical use by means of simple and cheap instruments.

TO INVESTIGATE the cost of its product, a certain power company spends thousands of dollars a year experimenting in boiler-furnace operation. Some tests cost over a hundred dollars each. The resulting profits are manyfold to a large company because the expense of experimenting is shared by a hundred large units, and the gross returns are multiplied accordingly. But the average industrial plant cannot afford special coal and water scales, special measuring instruments and piping and the technical help for complete plant tests. The large power producers must do most of the pioneer work in boiler-plant design and operation. Easy experimental methods would undoubtedly lead to radical developments in industrial power-plant methods.

The object of this writing is to point out the significance of a simple and cheap method for determining evaporative boiler efficiency. This method is to measure the average temperature of the flue gas where the gas leaves the boiler-heating surface, to analyze for CO_2 content an average sample of flue gas from the same source, and to apply these two determinations to the efficiency chart, Fig. 1. Thus, flue-gas temperature and CO_2 percentage are assumed to be the only variable factors of boiler efficiency. This is computed by dividing the difference between the heating value of the coal and the calculated losses by the heating value of the coal.

In calculating the total losses, certain operating conditions and accompanying losses actually variable, are assumed constant and there is necessarily an error in the computed efficiency. However, where Eastern coals are burned, such error is usually less than 2.5 per cent., sufficiently precise for comparative results. It is well to note conditions under which such assumed losses may vary. For example, the refuse loss here is assumed constant, while it actually varies according to the coal and the design and the operation of the grates. The radiation loss is assumed equal to 4 per cent. of the boiler output at builder's rating. In very large units, the loss is probably nearer 2 per cent. A boiler in a cold climate, other things being equal, cannot be so commercially efficient as one surrounded by air averaging 90 deg. But the error from the foregoing assumption will, upon close analyses of the charts, be negligible compared to the losses accurately measured by the flue-gas temperature and the percentage of CO_2.

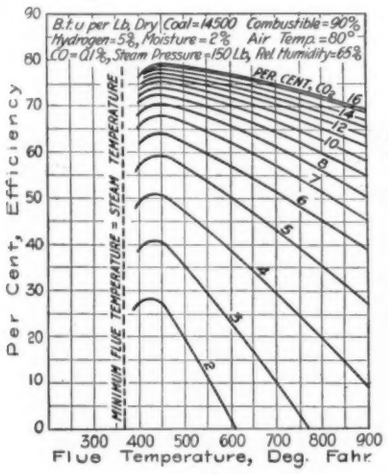

B.t.u per Lb. Dry Coal=14500 Combustible=90%
Hydrogen=5%, Moisture=2% Air Temp.=80°
CO=0.1%, Steam Pressure=150 Lb, Rel Humidity=65%
PER CENT. CO2
MINIMUM FLUE TEMPERATURE = STEAM TEMPERATURE
Per Cent, Efficiency
Flue Temperature, Deg. Fahr

FIG. 1

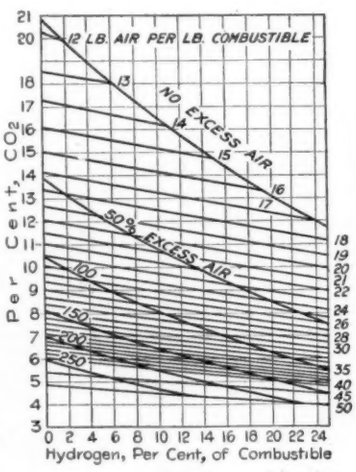


FIG. 2

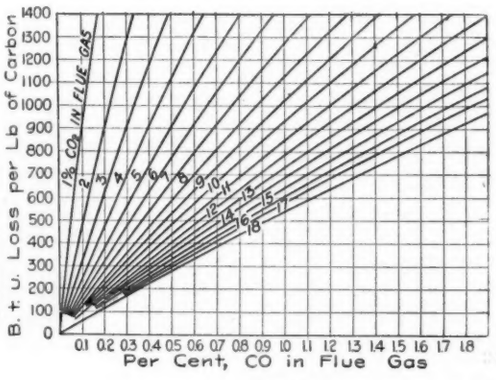


FIG. 3

FIGS. 1 TO 3. CHARTS SHOWING VARIOUS LOSSES IN STEAM-BOILER FURNACES

Fig. 1—Combined boiler efficiency indicated by CO_2 and flue temperature. Fig. 2—Effect of excess air on CO_2 in gas varying amounts of hydrogen in fuel. Fig. 3—Furnace loss on account of incomplete combustion of carbon

Heat losses may be divided into two classes: Those measured by CO_2 and flue temperature, and those measured by flue temperature only.

Loss in Dry Flue Gas—By itself, the percentage of CO_2 does not even measure boiler efficiency. In simple language it indicates the weight ratio of air to fuel when the proximate analysis of the coal is known. A CO_2 content in flue gas, formed from pure carbon burned in air, indicates one proportion of air to fuel, the same percentage CO_2 from the combustion of natural gas or soft coal indicates another. This difference is due largely to the varied proportions of hydrogen in the fuel hydrocarbons or the volatile combustible matter. Thus 8 per cent. CO_2 from a natural-gas burner may mean just as good an air ratio as 12 per

cent from a soft-coal furnace. Hydrogen burns to water vapor, condenses in the gas-analyzing apparatus and thus the percentage of nitrogen and gases insoluble in the Orsat chemicals is increased. The greater the percentage of hydrogen the less will be the possible CO_2 percentage. Fig. 2 indicates a possibility of 20.9 per cent. CO_2 from the burning of pure carbon and an impossibility of greater than 18.5 to 19 per cent. CO_2 for soft coal containing 4 or 5 per cent. hydrogen.

In hand firing, where heaps of green coal are generally quickly thrown upon the grates, volatile matter therein is distilled and burned first in greater proportions than the fixed carbon. Low CO_2 at first results, incorrectly indicating an excessive air supply. After most of the volatile matter is distilled, the higher CO_2 follows, indicating a lower than actual air ratio. A stoker feeding coal at a uniform rate produces CO_2 more nearly indicative of the actual air mixture.

In any event, snap analyses of flue gas are worthless as clues to the problem of producing the lower fuel cost per unit of manufactured product. A recording analyzer helps in the study of transient furnace conditions, but records of individual analyses are open, in some degree, to the foregoing objection. Then too, the boiler must be large to acquire a profit from an instrument costing $250 to $300.

A plain Orsat CO_2 analysis of an average tank sample of gas collected over a given period shows all the flue gas analytical data of interest to the average plant superintendent. A sampling tank costs about one-tenth the price of a recorder.

The heat loss in dry gas at flue temperature is calculated as follows:

Heat Loss (B.t.u. per lb. of dry coal) $= WS(Tf - Ta)$

where

W = Pounds of flue gas per pound of coal determined from proximate analysis of coal and Fig. 1;

S = Specific heat of flue gas, assumed constant for all temperatures;

Ta = Temperature of the air assumed at 80 deg. F.;

Tf = Temperature of flue gas.

Loss Indicated by Presence of CO in Flue Gas—Carbon monoxide (CO) is a result of the incomplete combustion of carbon and oxygen, and while the loss from it is not strictly measured by the percentage of CO_2, it is affected thereby. For example, from Fig. 3, 0.1 per cent. CO shows a loss of 320 heat units per pound of carbon when the flue gas is 3 per cent. CO_2, but a loss of only 70 units when the CO_2 is 14 per cent.; that is, the less the excess air the less the proportionate loss from incomplete combustion of coal. CO indicates a shortage of air required for complete combustion either locally or generally, and usually results from too heavy a fire for a given draft, stratification of gas on account of an uneven fire, or from the passage of hot CO_2 over soot-laden tubes where it combines with enough carbon to form CO. Thus, CO_2 plus CO = 2CO. Most furnaces get too much air rather than too little, and generally CO is absent. In the calculated efficiency chart, CO is assumed at 0.1 per cent.

Loss on Account of Moisture in the Air Supplied for Combustion—All air contains moisture indicated in definite proportions by the wet- and dry-bulb temperatures as illustrated in Fig. 4. These temperatures, together with the percentage of CO_2, measure the ratio of moisture in air per pound of fuel. The loss from superheating this moisture to flue temperature is usually inconsiderable. In the efficiency chart it is calculated at about 12 B.t.u. per pound of coal burned.

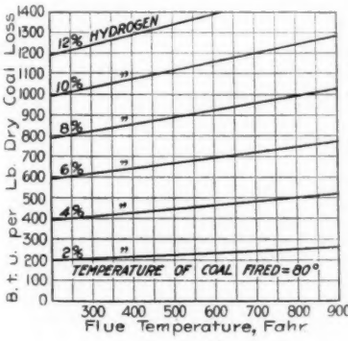


FIG. 4

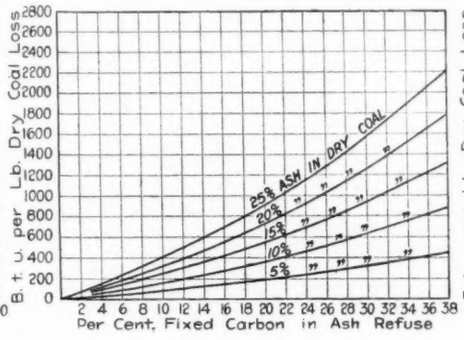


FIG. 5

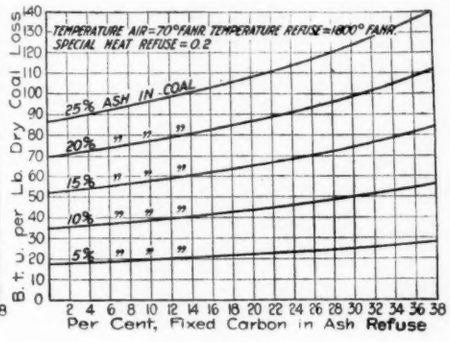

TEMPERATURE AIR = 70° FAHR. TEMPERATURE REFUSE = 1800° FAHR.
SPECIAL HEAT REFUSE = 0.2
B. t. u. per Lb. Dry Coal Loss
25% ASH IN COAL
20% " " "
15% " " "
10% " " "
5% " " "
Per Cent. Fixed Carbon in Ash Refuse

FIG. 6

FIGS. 4 TO 6. CHARTS SHOWING VARIOUS LOSSES IN STEAM-BOILER FURNACES

Fig. 4—Loss on account of hydrogen in coal. Fig. 5—Heat loss to ashpit from unburned carbon. Fig. 6—Sensible heat loss to ashpit

Loss on Account of Refuse—Soft-coal refuse usually contains both volatile and fixed carbon; but generally the volatile is negligible. Fig. 5 shows the loss from unburned combustible calculated on the fixed-carbon basis. This loss depends not only upon the percentage of combustible in the refuse, but also upon the percentage of ash in the coal. The poorer the coal with respect to ash the higher will be the refuse loss. The quality of the coal and the design and operation of the furnace are factors in boiler efficiency. The loss due to sensible heat of the refuse shown in Fig. 6 is small.

Loss on Account of Moisture in the Fuel—Moisture fed to the furnace with the coal, evaporated and superheated to the flue temperature, carries heat up the chimney. Ordinarily, as shown in Fig. 7, this is a minute loss.

Loss on Account of Hydrogen in the Fuel—When 1 lb. of hydrogen is burned, 9 lb. of water vapor is formed. Consequently, when a pound of coal containing 5 per cent. hydrogen is burned, 0.45 lb. water vapor is formed and this as superheated steam carries about 550 heat units to the chimney. It will appear from Fig. 7 that this loss, in the case of fuel oils and natural gas high in hydrogen, may be very high.

Since the bomb calorimeter, measuring the heat value

of coal, is jacketed by cold water, to absorb the latent heat in the water vapor burned hydrogen, the coal is credited with the 550 heat units which must be lost in the flue. That is, water vapor under atmospheric pressure will not condense at temperatures above 212 deg. F.; and since the flue temperature is always higher than this, the latent heat in the flue-gas vapor cannot be reclaimed to produce steam.

TABLE I. TEST ON SPECIAL 2365-HP. STIRLING BOILER AT DELRAY STATION, DETROIT, MICH., BY D. S. JACOBS, 1910, JOURNAL A.S.M.E.

Flue Temperature, Deg. F. Observed	CO_2 per Cent. Observed	Efficiency by Regular Method	Efficiency by Chart	Efficiency per Cent. Error of Chart
480	14.33	79.88	79.0	—0.88
483	14.40	81.15	79.0	—2.15
576	11.95	77.84	74.0	—3.84
670	14.74	75.78	75.0	—0.78
636	14.69	76.73	75.5	—1.23
487	11.86	77.90	75.5	—2.45
493	13.69	80.29	77.5	—2.78
575	14.00	77.07	76.0	—1.07
647	14.20	76.42	75.0	—1.42
651	15.45	75.84	75.5	—0.34

Loss on Account of Boiler Radiation—Depending upon the design of the setting, the radiation loss is about 4 per cent. of the rated boiler output. That is, from a 500-hp. boiler, the radiation loss is about $0.04 \times 500 \times 33{,}479 = 669{,}580$ B.t.u. per hour. The loss per unit of output will vary inversely as the output; that is, it may be infinity at zero output, and it approaches zero as the output indefinitely increases. The maximum flue-gas temperature at zero is that of boiler water. Its rise above boiler-water temperature varies almost directly with the load. Consequently, the radiation loss per unit of output and per pound of coal fired varies inversely as the rise in flue temperature above the steam temperature. This is illustrated by the hyperbolic curve of radiation loss per pound of fuel in Fig. 8.

Total Heat Losses—The general conditions assumed constant to calculate the efficiency and heat-loss curves are as follows: Combustible in coal, 90 per cent.; hydrogen in coal, 5 per cent.; moisture in coal, 2 per cent.; air temperature, 80° F.; CO, 0.1 per cent.; steam pressure, 150 lb. gage; relative humidity, 65 per cent.; combustible in refuse, 20 per cent. With these assumptions Figs. 8 and 9 respectively show heat losses measured by CO_2 percentage and flue-gas temperature and those measured only by flue-gas temperature. The combined losses are shown in Fig. 10.

Except for the radiation losses, the total heat losses are accurately determined and the error in radiation loss is practically negligible at flue temperatures above 475 deg. F. Little interest is attached to points of lower temperatures.

It appears that for any percentage of CO_2 there is a certain flue temperature at which the total heat losses per pound of fuel is a minimum, and this is the point of maximum efficiency.

To compute the efficiencies in Fig. 12, 200 B.t.u. were added to the losses to account for undetermined losses.

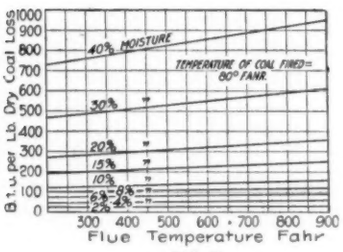


FIG. 7

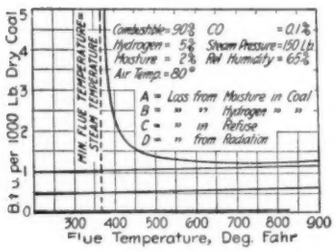

B.t.u. per 1000 Lb. Dry Coal
Combustible = 90% CO = 0.1%
Hydrogen = 5% Steam Pressure = 150 Lb
Moisture = 2% Rel. Humidity = 65%
Air Temp. = 80°
MIN. FLUE TEMPERATURE = STEAM TEMPERATURE
A = Loss from Moisture in Coal
B = " " Hydrogen " "
C = " in Refuse
D = " from Radiation
Flue Temperature, Deg. Fahr

FIG. 8

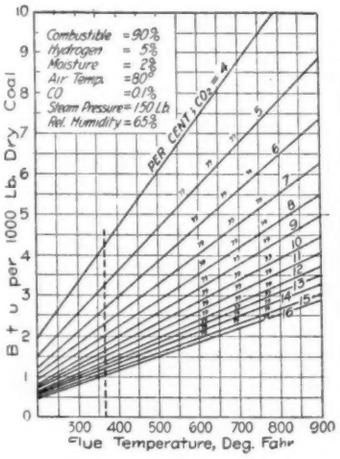

B.t.u. per 1000 Lb. Dry Coal
Combustible = 90%
Hydrogen = 5%
Moisture = 2%
Air Temp. = 80°
CO = 0.1%
Steam Pressure = 150 Lb.
Rel. Humidity = 65%
PER CENT. CO2 = 4
Flue Temperature, Deg. Fahr

FIG. 9

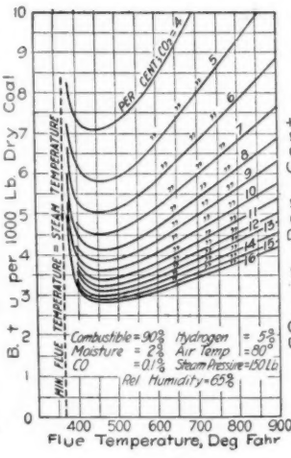

B.t.u. per 1000 Lb. Dry Coal
PER CENT. CO2 = 4
MIN. FLUE TEMPERATURE = STEAM TEMPERATURE
Combustible = 90% Hydrogen = 5%
Moisture = 2% Air Temp. = 80°
CO = 0.1% Steam Pressure = 150 Lb.
Rel. Humidity = 65%
Flue Temperature, Deg. Fahr

FIG. 10

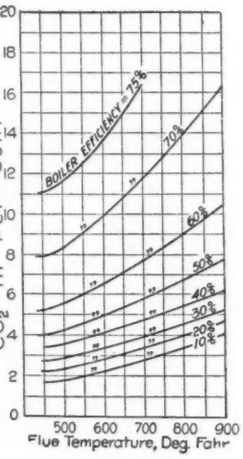


FIG. 11

FIGS. 7 TO 11. CHARTS SHOWING VARIOUS LOSSES IN STEAM-BOILER FURNACES

Fig. 7—Heat loss due to moisture in coal. Fig. 8—Furnace losses measured by flue temperatures independent of CO_2. Fig. 9—Furnace losses measured by CO_2 and flue temperature. Fig 10—Furnace losses measured by flue temperature, with and independent of CO_2. Fig. 11—Relation between CO_2 and flue temperatures for constant boiler efficiency.

Tables I and II illustrate the close practical accuracy of the curves.

More clearly in Fig. 11 are shown the relative values of CO_2 percentage and flue temperatures in the determination of boiler efficiency. Suppose a boiler at 70

TABLE II. TEST ON 650-H P. BABCOCK & WILCOX BOILER AT WATERSIDE STATION, NEW YORK CITY, BY THE NEW YORK EDISON CO., 1911

Flue Temperature, Deg. F. Observed	CO_2 per Cent. Observed	Efficiency by Regular method	Efficiency by Chart	Efficiency per Cent. Error of Chart
523	12.4	74.3	75.4	+1.1
533	11.7	75.9	74.7	—1.2
541	11.4	75.2	74.1	—1.1
497	13.7	75.5	77.2	+1.7
505	11.8	77.0	75.4	—1.6
509	11.1	76.5	74.6	—1.9
491	11.2	75.1	74.8	—0.3
512	12.2	76.9	75.5	—1.4
574	11.2	73.9	72.8	—1.1
571	16.5	73.2	77.5	+4.3
665	..	..	..	..
695	..	..	..	..
505	10.5	75.1	73.8	—1.3
593	14.3	73.4	76.0	+2.6
555	13.0	76.8	75.4	—1.4
571	11.9	74.5	73.8	—0.7
507	13.4	80.1	76.8	—3.3

per cent. efficiency shows 10 per cent. CO_2 and 610 deg. F. flue temperature. Let the air leakage of the boiler setting be eliminated and the firing be improved so that the CO_2 is raised to 12 per cent., but at the same time let the baffles deteriorate and allow the soot to build

on the tubes until the flue temperature rises to 710 deg. F. Then the efficiency will still be about 70 per cent., and all the good operating work will be nullified by the slovenly maintenance. It is a great thing to key up

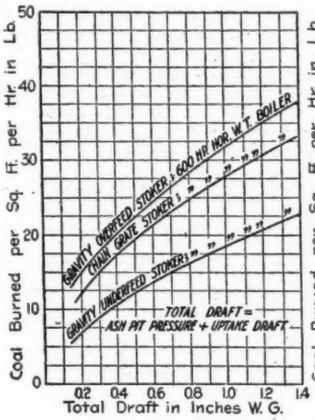

Coal Burned per Sq. Ft. per Hr. in Lb.
50
40
30
20
10
0
GRAVITY OVERFEED STOKER, 600 HP. NOR. W. T. BOILER
CHAIN GRATE STOKER, " " " " "
GRAVITY UNDERFEED STOKER, " " " " "
TOTAL DRAFT = ASH PIT PRESSURE + UPTAKE DRAFT
02 04 06 08 10 12 14
Total Draft in Inches W. G.

FIG. 12. EASTERN SOFT COAL COMBUSTION RATES ON DIFFERENT STOKERS

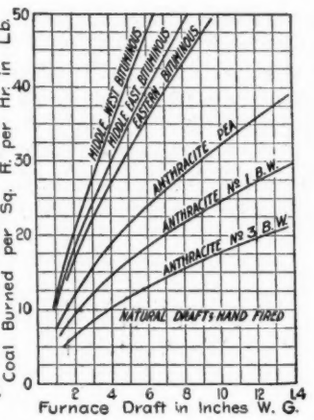


FIG. 13. COMBUSTION RATES WITH NATURAL DRAFT, HAND FIRING

the firemen, but it is just as important to key up the repair gang and have proper machinery. Notwithstanding the vast amount of literature showing the value of flue-gas analysis in boiler operation, good soot blowers and a good repair boss are the most certain elements in producing boiler-room results with given apparatus.

A draft gage used in connection with Figs. 12 and 13 shows data necessary to determine approximately the rate of combustion, and from this and the efficiency determination the boiler output may be closely estimated.

Thus, valuable boiler-operating data can be obtained for practical use, through simple and cheap instruments, and except where extreme accuracy is essential, elaborate boiler tests are neither necessary nor advisable.

Some Pipe-Threading Hints

Did you ever hear of W. J. Willis? Probably not, because he was only an engineer in a small New England manufacturing city and the worst that could be said about him was that his wife never knew when to have his evening meal prepared, because she never knew when he would be home to eat it.

The real trouble was that Willis liked to talk shop, and he probably knew more engineers in the town than there were dead cats to the credit of his pet bulldog, which was going some. Because of his wide acquaintance it was as difficult for him to pass an engine room without stopping as it would be for a fully developed souse to pass a barroom without wanting a drink.

One evening on his way home he stepped into the engine room of a small plant, where he found young Stetson busily engaged in cutting threads on a length of pipe.

"Caught you right in the act, didn't I?" was Willis' greeting. "What are you doing? Making a lot of poor threads on that pipe end?"

"Yep," answered young Stetson, "but I guess they will answer so long as I can get the joint tight when it's made up. The threads are pretty ragged, but I'll put a lot of dope on them when they are screwed into the fitting."

"You have the same false notion that so many engineers and some pipefitters have; that is, that any kind of a thread will answer so long as it can be made tight at the first go-off. You ought to know, and you probably do know, that there is a standard thread embracing pitch, depth and length of cut, when it comes to cutting a thread, and at a steam plant almost any departure from the standard can be expected. Some of the threads are cut small and do not fit in the fittings, some are

FIG. 1. "WHAT ARE YOU DOING? MAKING A LOT OF POOR THREADS?"

stripped and others do not have the proper taper. Often it will be found that purchased pipes have threaded ends that do not conform to the standard."

"Well, what's the odds so long as a fellow can make a tight joint? Let the other fellow worry after the job is up."

"Young feller," replied Willis, as he examined the stripped threads Stetson had just cut, "when making a pipe connection that is to be under steam pressure, one should remember that with the failure of such a joint

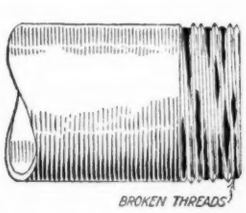


FIG. 2. STRIPPED THREADS

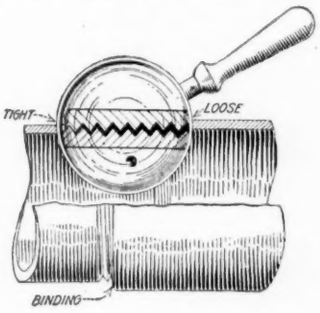


FIG. 3. A POOR PIPE JOINT

there is the possibility of injuring or killing one or more workmen. There is no excuse for making a faulty joint as one can easily determine when screwing up the joint whether it is going together properly or not. Now there ain't any sense in making up a joint with the threads stripped like these are." See Fig. 2.

"Say, Willis, what makes these threads strip so? Of course, I don't pretend to know much about pipe work, and if you can give me a pointer it will be all to the good, and perhaps it will save a little extra work on my part; this die does go hard."

"The reason your threads are stripped in the cutting is because you did not use enough oil on the dies, or because the die is so dull it wouldn't cut musty cheese. Under such conditions when you begin to cut a thread, the chips pack in the die and the threads are stripped just as you have them here. A little care on your part will prevent that kind of work.

"Now just you take this hint, Stetson. After you have the die started, don't think that the diestock has got to be revolved like a windmill. Instead of making a complete turn and bracing your foot against the bench in order to turn the die as you were doing when I came in, just try turning it a partial revolution, then back the die off and go ahead again, using plenty of lard oil. If you will try that way of cutting a thread, you won't have any trouble even with a dull die. Oil and backing the die are what count. Furthermore, don't be afraid of making the threaded end of the pipe long enough to screw well into the fitting."

"What's the difference?" asked Stetson, as he carelessly wiped his hands on a dirty piece of waste. "What's the difference so long as you get enough threads in the fitting to hold? Cutting threads is no cinch."

"For one thing, cutting a short thread is inexcusable and represents carelessness on your part, a trait that is dangerous for anyone to develop, especially an engineer. For another thing, it is almost criminal to make up a joint with but two or three threads engaging in the fittings. You can't make a joint that is to withstand steam pressure any too strong for safety, and there is the danger of a faulty joint pulling apart."

"Gee! I hadn't thought of that. One thing you said when you first came in I can't quite get through my noodle. How are you going to get a pipe thread so small that it won't fit tightly in a fitting?"

"That is the easiest thing in the world with certain kinds of thread dies. With the solid dies there is not the danger of making small threaded ends, but with the adjustable type of dies they can be so set that the pipe end is cut small, although the threads may appear to be perfect. Such a thread will not fit snugly in the fitting, and the joint is made tight only by screwing the pipe into it so far that the butt end of the thread is forced in against the outer end of the fitting." See Fig. 3.

"Such a joint, although it may hold for a time, will eventually begin to leak. This action is hastened where water is used that is of a character to rapidly corrode wrought iron or steel piping, because it has a chance to get in between the threads and act upon them. As the pipe is comparatively thin at the bottom of the threads, it does not take long for the metal to waste to a thin skin. Of course, the corroding action will be slower when the pipe carries steam, but the pipe joint will fail much sooner than if it were properly made.

"Now take my advice, cut the end off that piece of pipe and then use plenty of lard oil; and don't neglect to back off that die in making a new thread. While you are doing that, I'll toddle along home where I belong."

In cutting pipe it frequently happens that the cutters depress the pipe, reduce the area and leave ragged edges on which foreign substances gather. Do not use a nipple or piece of pipe without looking through it for blisters and obstructions, as this may save trouble later.

Turbine Speed Decreased

By E. C. Parham

A characteristic feature of all automatic governing devices is that a change must take place in the quantity governed before the governor can act to check the change and restore the governed quantity approximately to its original value. If speed is the quantity that is being governed, the speed actually must change a little in order to start the governor on its cycle of constant-speed maintenance. The governing device that most promptly responds to slight variations and prevents them from becoming heavy variations, either temporary or permanent, is the device to be desired.

The connections were checked, and found to be all right, of two 50-kw. 250-volt compound-wound direct-current generators, driven directly from two water-wheels, preparatory to paralleling them for the first time. The machines were brought up to speed and voltage, and as a final check on the polarities, the switch and breaker of one machine and the breaker of the other machine were closed, then the voltages above and below and across the remaining switch were measured with a voltmeter. As the voltages above and below the switch were equal and the voltage across the switch was zero, the proper condition for paralleling was insured. A moderate load then was put on one machine and the switch of the other machine closed, thereby placing the machines in parallel. They divided the load fairly well at first, but there soon appeared a tendency of first one machine and then the other to take most of the load. Speed variations of the turbines was evident, and on throwing on a much heavier load, the speeds dropped way down and the governors tripped out the turbines.

Investigation disclosed that the oil system of the governors was full of bits of thin paper that clogged the governor parts so that they could not function properly. Before satisfactory operation could be secured, the whole oil-piping system had to be disconnected and cleared of the paper that came from no one knew where.

Some Tall Chimneys

What is claimed to be the tallest chimney in the world, at Sagonoseki, Japan, is made of concrete and is 570 ft. tall and is on a hill 430 ft. high. It is 26¼ ft. inside diameter at the top and 42 ft. at the base. The foundation is 95 ft. in diameter and contains 2700 cu.yd. of concrete. For 150 ft. the chimney is reinforced by a concrete lining, separated from the outer concrete shell by a 5-ft. air space. In the construction of the chimney 400 tons of steel was used. The one next highest is in Montana, 506 ft. Others are as follows: At Port Dundee, Scotland, 488 ft.; Townsend, Glasgow, Scotland, 454 ft.; Freiburg, Saxony, 453 ft., on hill 259 ft.; Mechernich Lead Mining Co., 440½ ft.; Tennant & Co., Glasgow, Scotland, 434 ft.; Crossley's, Halifax, England, 381 ft.; Metropolitan Street Ry. Co., New York City, 353 ft.; Omaha & Grand Smelting Works, Denver, Colo., 350 ft.; Fall River Iron Co., 350 ft. The American Smelting and Refining Co. is constructing a chimney at Tacoma, Wash., that will be 420 ft. high.

Editorials

Exhaust Steam Waste

CONSERVATION, the keynote these days, looms up morning, noon and night. It is conserve this, that and the other thing, all of which is the proper procedure in every field of labor and endeavor. No doubt about it.

This war will do for the American people what nothing else would have accomplished, and that is, they will be brought to the realization that they can easily do without many things that have been deemed actual necessities. It will also bring out the fact that they have left undone many things that they could have done and that they have allowed waste to go on unchecked just because no one took the initiative.

For weeks past the newspapers have published articles dealing with the coal shortage and the necessity of saving fuel. Other items have urged the immediate development of water power, to be under Government control, in order to reduce consumption of coal for industrial and commercial purposes. Although more coal was mined in 1917 than in 1916, there is not enough to meet the demand, because of car shortage and other reasons. To overcome this shortage, manufacturers and householders have been and are being urged to economize in fuel in every way.

Has it ever occurred to the Fuel Conservation Commission that the coal consumption of the country could be cut down thousands of tons each year by simply employing a little engineering ability, whereby the steam-plant owner and the householder could be of mutual benefit to one another, and at the same time make a saving in fuel that would be astonishing?

About eighty per cent. of the heat value in every pound of coal consumed in a power-boiler furnace is allowed to go to waste through the engine exhaust to the atmosphere. In all cities there are hundreds of these exhaust pipes discharging to the air, after passing through a steam engine, steam which could be used to advantage in the adjoining buildings that are equipped only with a heating boiler. It would require but slight pipe extensions in most cases to connect these hundreds and thousands of noncondensing engines to the heating systems of adjoining properties, thus supplying their heat requirements with steam that is now going to waste. This would enable thousands of heating boilers to be shut down, and the coal that they burned would be saved and could be delivered to such plants as are in urgent need of it for power purposes.

This journal has and does favor what is termed the isolated-block central station for just the very reasons that now confront this country as a whole—the cheaper production of power, light and heat. This idea has been developed to a limited extent in the larger cities, but not by any means on such an extended line as conditions warrant and the present time demands.

In support of this contention there are steam plants that generate steam for no other purpose than to supply heat to properties not as a byproduct, but as a commercial business pure and simple. With the outlay for underground piping and upkeep there is a good profit in carrying on the business, notwithstanding the fact that the demand for steam heat during the summer months is practically cut out, the requirement being mostly for units using steam for power purposes only. We have in mind one large central station in which the reciprocating and turbine units were operated noncondensing and exhaust steam sold to customers who did away with or had not put in heating boilers.

These instances go to emphasize the fact that exhaust steam is valuable as a heating medium, and there is no dodging the fact that the lack of action to prevent the continued waste of steam is responsible for the unnecessary burning of thousands of tons of coal.

Not only would there be a saving of fuel by the steam consumer and producer getting together on the heating question, but both could make money by so doing. The steam producer would by such an arrangement get his power for practically nothing, and the consumer would obtain his heat cheaper than he could produce it himself. More than that, there would be men released from these isolated heating plants who are needed in other channels of labor.

Why not work along more practical lines, and if there are any regulations that stand in the way of utilizing waste steam, as should be done, the Government surely has the power, as a war measure, to set these regulations aside for the common good of all.

What Do I Get Out of My Society?

THIS is a question which is often asked, especially by the isolated member. He sees others rise to positions of preferment and distinction in the society and the vocation or profession which it serves and is prone to conclude that he is contributing to the emolument of a few, favored by location or influence.

It may seem to be an irritant to his discontent to tell him that the most valuable privilege that his membership in a vocational or professional society offers him is an opportunity to give, but it is a thought the consideration of which may lead to a solution of his dissatisfaction.

Such a society is, in effect, a massing of the means and endeavors of its members for the uplift of the group, for the doing of those things which can better be done collectively than individually. If the society is truly representative, if it includes the best and accepts only reputable and recognized practitioners, his acceptance into it is in itself a mark of standing and of recognition not without value. The greater the society becomes in influence, in achievement, in usefulness to the members and service to the public, in the professional and general estimation, the greater the value of his membership in it from this point of view; and it is as much his duty and privilege to aid in making it great as it is that of

any other member. If everybody's interest and effort ended with the payment of his dues, the society would die from inertia.

But to the man whose professional interest is not bounded by his individual practice, membership in a live society offers the avenue for participation in the wider activities and identification with the achievements of the profession; and he will find that the dividends that he receives upon his membership will increase in proportion with his own share in the common effort. Attendance at the meetings, joining in the discussions, by correspondence if presence is impossible, the presentation of papers, correspondence with their authors, exchange of views and information with fellow-members, willingness to do committee work, activity in enlisting desirable new members will lead to an extension of one's acquaintanceship, to a recognition of his attainments, to a knowledge of his specialties, and to a standing in the society and profession commensurate with his true worth. A society that is seeking to do things is always scanning its membership list for those who can be made use of in accomplishing its purposes; and those who come forward, not in a spirit of self-seeking but of sincere interest, and take an intelligent part in the work are the ones to whom the opportunities come for greater usefulness and through it to preference and emolument.

Determination of Boiler Efficiency by CO_2 Analyses and Flue Temperatures

ELSEWHERE in this issue appears an article showing many curves, by the aid of which the boiler efficiency may be closely approximated without the use of the usual large number of instruments and without lengthy calculations. The method is to measure the average temperature of the flue gas where the gas leaves the boiler-heating surface, to analyze for CO_2 content an average sample of gas from the same source, and apply these two determinations to a chart. The flue-gas temperature and the CO_2 percentage are assumed to be the only two variable factors of boiler efficiency.

Mr. O'Neill, the author of the article, is well known to the readers of *Power*. It is hoped that the curves presented by him will be of especial value at this time, when fuel economy in the boiler room is so important to the national welfare.

The New Military Cantonments

THE magnitude of the task of building and equipping sixteen cities, each to house from thirty-five to forty-five thousand men, is not fully realized by many, and the panoramic views on another page cannot even show the entire extent of one of them, but are intended to give a general idea of the appearance of an army cantonment. Criticism of the speed and execution of the work seems entirely out of place when one of the finished cities is viewed. One camp, for example, has about eighteen hundred Government buildings, which required for their construction some fifty million feet of lumber. The military reservation is nineteen thousand acres in extent, with ten miles of crushed-stone road, thirty miles of earth road and ten miles of railroad, thirty-five miles of water mains and thirty miles of sewerage system discharging two miles from camp. Material was unloaded at the rate of one carload every six minutes, day and night, for several weeks. At one time the contractors had a force of over fourteen thousand men employed, and the weekly payroll was approximately four hundred and fifty thousand dollars.

In view of the staggering undertaking of converting a peace-loving country and people into a huge military camp and machine, the showing made in the short period of time is truly marvelous and utterly discredits the rabid croakers whose chief business seems to be giving comfort to the enemy by charging inefficiency and lack of speed in the execution of the work. The only error appears to have been in the estimated time of completion. In other words, the work has been done as rapidly as was humanly possible, all things considered; therefore there can be no criticism of efficiency in doing, but simply that insufficient allowance was made in the estimate for inevitable delays and shortage of manpower, which could not possibly have been estimated with any degree of accuracy.

It takes a pound of coal to keep about twenty-five of the small ten-watt lamps that are used in electric-sign work running for an hour. It would run only ten of the ordinary twenty-five-watt tungstens, or seven of the forty-watt lights often used in residences. Of the best of the sixteen-candle carbon lamps it would supply only about five. The two hundred to seven hundred and fifty-watt incandescent street lamps take from eight-tenths to three pounds of coal per hour each. Count up the lamps that you see burning needlessly in lighting up streets before sunset, in running Great White Ways, in decorating store windows, or carelessly left burning in your own home, and see if a substantial saving could not be made by suppression and repression, which would cause no suffering and little, if any, inconvenience.

"The doors of the Edison Company in Detroit are wide open to anybody coming with a legitimate inquiry. Come and see us. We will tell you all we know and show you anything we have," said President Dow, of the Detroit Edison Company, to the Electro-Chemical Society at its recent meeting. This is the spirit that has wiped plagues from the earth, educated the lowly, built the United States and which gets the world nearer that material and spiritual ideal that big men know must come.

Savings-bank deposits pay four per cent. interest or less and are subject to taxation. Banks sometimes suspend payment and fail. War Savings Certificates pay four per cent. and are not subject to United States, state or local taxation, netting therefore more than the usual savings-bank interest. They are the safest investment in the world and the best paying for anything like the same degree of security. Subscribe today.

The Alcohol Fuel Committee of Australia, St. James Street, London, Eng., is looking for a good motor that will use that combustible. Got one? And this follows on the heels of the Prohibition movement!

Correspondence

Saving Coal in the Home

The editorial appearing in the Jan. 1 issue of *Power* is of interest to every reader, not because he uses coal in one way or another in producing power, but because it applies to the management of his home furnace. The idea expressed is commendable, but many of us would like to know how the one shovelful is to be saved each day with the grade of coal that is being sold at a higher price than one could buy good coal for one or two years ago.

Take my own case, for instance. Before the heating season began, the steam-heating boiler in my house was thoroughly cleaned, all leaks were stopped up, and everything was put in first-class order for heating the lower floors and the bathroom on the second floor of the house. Excepting in very cold weather, one radiator and a kitchen hot-water tank, the water in which is heated by running a circulating pipe through the boiler furnace, will comfortably heat four downstairs rooms.

There is no use in carrying a fire so low that steam will not be generated; if so, the fire is practically banked and the fuel is being burned without heating the house. Therefore it is necessary to carry a fuel bed thick enough to maintain a steam pressure, and with automatically controlled dampers the steam pressure is kept practically constant. Coal is put on the fire morning and night and at no other time, excepting in very cold weather.

Shaking down is stopped as soon as a spark of live coal drops into the ashpit, so very little coal gets into the ashes. However, it is taking more coal to heat the house this winter than it has before, and there is a reason. Judging from the coal that I have been able to get, the slate pickers at the mines have either struck, gone to war or are asleep on the job. Nobody but a blind man would allow the amount of slate to get by that I have bought, unless it was purposely done. More than that, the coal contains an excessive amount of ash, which, together with its slate content, reduces its heating value to a low standard.

If manufacturing and power plants are getting as low a grade of coal at a price equal to or higher than they have been paying, and if it contains an increase of ash and slate over former coals in proporton to the increased refuse in the coal I am burning in my house boiler, it is no wonder that there is a shortage of cars for its transportation from the mines. In my own case it will probably require between one and two tons more coal to heat the house this year than it has previously, and if this holds good in every case, of house heating, then there will be required (using the figures in the editorial) between 15,000,000 and 30,000,000 tons more of coal to do the same heating of homes than it did in former years with good coal.

I wonder if it is not a fact that the mine operators are mining coal this year that they could not find a market for in other years when there was not such a lack of transportation and a demand for coal of any kind. There is not much economy in any direction in transporting coal to market containing from 30 to 40 per cent. ash when the same cars could be used to carry coal low in ash, not any harder to mine and costing the same to buy as the trash that is now being sold as coal.

F. G. HIGGINS.

New York City.

Meeting the Emergency

I have read with interest the article by E. W. Miller on page 764 of the Dec. 4 issue, entitled "Meeting the Emergency," and give herewith my experiences while in central-station work, where the planning in detail what to do in case of an emergency came in good service.

The station is of about 45,000-kw. capacity and supplied all of the electrical power in one of the large cities in the East. As is usual, three classes of service were carried: The alternating-current incandescent and power circuits, direct-current incandescent and power circuits through motor-generator sets, and the city street-arc lighting.

Some time ago one of my articles was published (page 739, Nov. 19, 1912), outlining in detail a method of cleaning vertical turbine blades of boiler scale by pumping kerosene oil into the throttle while the machine was being run noncondensing. In order to save this oil instead of letting it go to waste through the hotwell, the exhaust was turned into an old feed-water heater to try to recover the oil. On the first trial this worked all right, the turbine being washed for about an hour and a quarter, using nearly seven barrels of kerosene. The machine had been shut down, when there was an explosion in the feed-water heater, due no doubt to the ignition of kerosene from spontaneous combustion, the force blowing one of the cast-iron heads off. In flying across the room, this hit the gravity lubricating-oil feed from the storage tanks, on the third floor, to the accumulator pumps. This line was located in the boiler-feed room under the boilers. The oil thus liberated spurted up under the 30- or 40-lb. pressure to the under side of the mechanical stokers, igniting and starting a blaze that soon got beyond control and drove the stoker attendants—in fact, all the help—from the boiler rooms.

The engine room was separated from the boiler rooms by a fire-wall, and at the time of the explosion we were operating a machine in the middle of the engine room. I was on the switchboard in charge of the load and was notified by the floor engineers at 4:20 a.m. that the engine room was on fire and it would be necessary to change the load from No. 3 turbine to No. 1 engine, as No. 3 was dangerously close to the seat of the fire, and a reciprocating engine would have to be put on the line because the accumulator was rapidly going to the length

of its stroke and there was danger of burning the step of the turbine. The reciprocating alternator was immediately brought up to speed, thrown on the line and a load of about 5000 kw. transferred to the reciprocating engine at 4: 46.

In the meantime two of our substations which carried auxiliary steam units had been notified to bring their machines to full speed and be prepared to take the maximum load that their units could carry. By this time the oil supply had been entirely lost and we were operating the reciprocating units simply with splash oil, endeavoring to keep them cool with increased water circulation on the bearing jackets.

We immediately split up the remaining load, cutting over all the direct-current district onto one of the substations, thus reducing the load on the main station. This was accomplished without a hitch at 4: 50. At 5: 17 a.m. the engineer on the floor notified me that the reciprocating alternator must come off the line as the oil on the governor had been lost and the bearings were heating up. This necessitated cutting out all the street-lighting load and transferring the remaining alternating-current incandescent load to another substation. The reciprocating alternator was pulled off the line immediately, thus shutting down the station.

In the meantime the engine room had become so clouded with smoke that all the oilers and engine tenders were compelled to go outside the building. The switchboard-operating room was inclosed in a glass cage, which proved to be smoke-proof, and I with my assistant was able to stick on the job, we having ready a rope as a means of sliding down to the street level from the window should the operating room become untenable.

At 5: 28 all the load had been safely transferred, with the exception of the street arc lighting, to the substation, and things were running along smoothly. By 6 o'clock the direct-current load began to pick up and the current began to rise to a dangerous point on our machine, which we took care of by raising the voltage four volts on the substation steam sets, thus reducing the current, and in this way we were able to carry the entire direct-current load without interruption.

When the alternating-current load began to pick up, it was simply a question of dumping one circuit after another, thus keeping down the load to a safe limit, we having arranged, months before, just which circuits were to be pulled first should such an emergency arise.

In the meantime a fire alarm had been sounded and the engines from the city fire department responding had been able to finally extinguish a rather stubborn blaze, which lasted until about 8: 30. The oil lost was replaced by an emergency call sent to a large local oil retailer, who loaded up several thousand gallons of engine and cylinder oils and sent them around on trucks. These were pumped off into the storage tanks, and at 8: 55 the reciprocating alternator had been put on the line, and all the load was back on the station in normal running condition at 9: 33, just five hours and 13 minutes from the time the alarm of fire was first given.

An idea of the intensity of the heat can be gained from the condition of the concrete floor slab of the boiler room directly over the spot where the fire occurred. This was warped up and cracked to such an extent that it was unsafe to walk across it until sufficient reinforcing planks had been laid to insure absolute safety.

Altogether there was a loss of 5000 gal. of lubricating oil, both cylinder and engine, besides a temporary shutdown on part of the system of five hours or less.

Needless to say, the practice of recovering kerosene by this method was abandoned from that time on, as we preferred to let it go to waste rather than run the chance of a second similar experience.

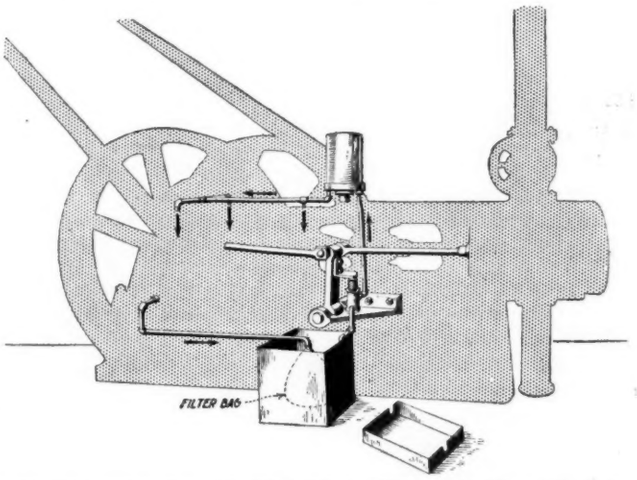
Philadelphia, Penn. MORGAN G. JOHNS.

Engine Oiling System

Engineers sometimes fail to take advantage of the opportunities they have and complain that the management is unwilling to purchase needed apparatus. Yet they could, if they would, do much to make up for the lack of equipment.

In a certain plant where the engineer is a "live wire," even though operating a plant of less than a hundred horsepower, the engine is not of the best, having given a lot of trouble because of hot bearings, etc.; but it is now doing first-rate, since the engineer rigged up a home-made oiling system for it.

The owner refused to purchase any new oiling devices, as in his estimation the power plant was only a



CONTINUOUS OILING SYSTEM APPLIED TO OLD ENGINE

necessary evil, so the engineer set about contriving a system of stream lubrication from odds and ends about the plant.

For an oil reservoir he used a ten-gallon can, with a cloth bag in it, tied to the end of the return pipe to filter the return oil. By removing this bag and substituting a clean one occasionally, the circulating oil is kept reasonably clean. For a pump he used the gasoline pump taken from an old gasoline engine. This pump was driven by a bracket bolted to the rocker-arm as shown.

The elevated tank is made of 8-in. pipe and a reducer and is fastened to the engine frame with a 2-in. nipple and flange.

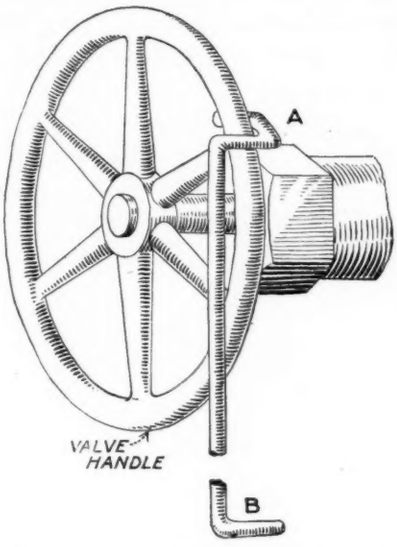
The pressure-feed lines are ¼-in. iron pipe, and worn-out valves that would not hold steam pressure are good enough to regulate the flow of oil with. A neat guard was fitted over the engine crank and did not allow the oil to splash over the floor.

It is an excellent example of what can be done with little to do with. E. S. MORRISON.

Dallas, Tex.

Operating Overhead Valves

A simple and easily made device for operating valves that are out of reach is shown in the illustration, and no other explanation seems necessary. If the valve is



HOOK FOR OPERATING VALVES

somewhat "stuck" or is to be closed "tight," the end *A* is used but in many cases the simple hook on end *B* will do the work. JAMES E. NOBLE.

Portsmouth, Ont., Canada.

Remembering Which Terminal of a Device is the Cathode

It is somewhat difficult to remember which is the cathode or anode of an electrochemical device or rectifier; that is, where the current enters or where it leaves the device. A professor, in a talk sometime ago, gave an example that is very easy to remember.

He had a cat that could open a screen door and go out, but could not open it to enter. By thinking of "cathole," the cat going out, it was easy to remember "cathode," the terminal at which the current left the device. Of course, if this is the cathode, the other terminal must be the anode. I have found it very easy to remember the difference between the cathode and anode since hearing this illustration.

Philadelphia, Penn. W. H. NOSTAN.

Engineers and Their Wages

I must say "A Union Engineer, Somewhere in Connecticut" on page 638 in the issue of Nov. 6, has learned the same lesson that I have; namely, that while the union scale is not fair to all, it is a good thing for the large majority. We cannot all get chiefs' jobs and their pay, but we can get lots of jobs requiring intelligent operators and through the union can get good pay. In the plant where I am we get $4.75 per day of eight hours and the firemen get $4.25 for eight hours. In the other plants outside of the union they work ten hours for $3.50 and $2.75 respectively.

Somewhere in Washington. A UNION ENGINEER.

Lubricating Corliss Valves

A Corliss engine "groaned" and the valves would stick so badly at times that the dashpots could not pull them shut, although the amount of oil that was fed was "outrageous."

The oil pump was piped to feed over the ends of the valves in the usual way, but after changing the piping to feed into the steam pipe just above the throttle, there was no further trouble and the amount of oil required was greatly reduced. N. C. GLEASON.

Northport, Wash.

The Use of Electric Hoists at Coal Mines

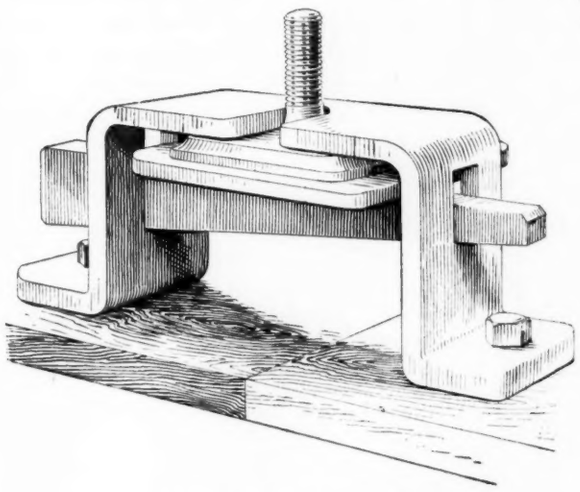
I would like to hear from readers of *Power* who have had experience with electric hoists at coal mines in Illinois, as to their reliability and economy over steam hoists, and under what conditions it is better to install an electric hoist in preference to a steam hoist.

It would also be of interest to know why one type of hoist is preferred over another, from the operating engineer's standpoint. W. F. DECKER.

La Salle, Ind.

Bench Clamp for Handhole Plates

It has been customary when cleaning our B. & W. boilers to have a couple of men run dies over the studs of the handhole plates, because when replacing the plates, if a nut is not easily screwed home, the plate will be thrown out of position and the gasket misplaced; so it is desirable that the nuts work freely.



BENCH CLAMP FOR HANDHOLE PLATES

Ordinarily, two bench vises were kept busy for this work, and often someone wanted to use one of the vises, and the work was temporarily stopped. The illustration shows a special vise, the use of which has reduced the time on the 2000 plates for two boilers from twelve hours to nine hours.

Perhaps this kink may be of assistance to some other fellow who has a lot of handhole plates to take care of. CHARLES H. WILLEY.

Concord, N. H.

Necessity of Air-Gap Gaging in Induction Motors

Most of the troubles arising in the use of induction motors are caused primarily by the failure of the operator to keep the air gap between the rotor and stator uniform. Consequently, if this point is carefully attended to, many delays and considerable rewinding expense will be avoided.

At the time an induction motor is placed in operation there is usually furnished a thin steel gage which should pass freely between the rotor and stator at any point. The gage is used during the installation and then probably lost or thrown away. After months or even years of operation the motor begins to heat; later, if not given proper attention, it may begin to smoke and if not attended to promptly will burn out the windings or otherwise be seriously injured.

When the air gap becomes uneven, owing to the bearings wearing down in an induction motor, the current consumption increases, the starting torque is decreased and the machine begins to heat. If these conditions are noted and properly diagnosed, the bearings will be replaced or adjusted and the motor becomes as good as ever; but if not, the condition grows worse until a shutdown results.

It is obvious that all repairs should be made before they are absolutely necessary; in other words, when they can be made at the convenience of the operator. Therefore it is good practice to use an air-gap gage periodically to determine the clearance between the rotor and stator. If this is done, the necessity of new bearings or adjustments becomes apparent before the motor efficiency is seriously impaired or abnormal current flow has injured the windings. By following this method the gain in efficiency of operation and in economy of repairs will much more than offset the cost of the additional bearings that may be necessary.

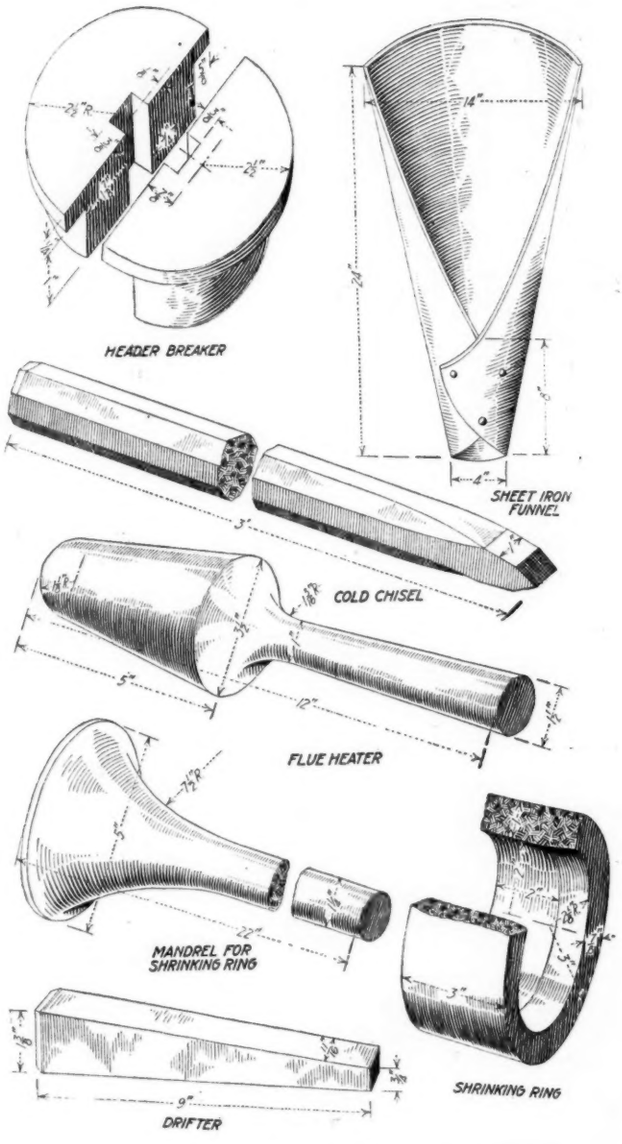
Johnson City, Tenn. D. R. SHEARER.

Replacing Boiler-Tube Headers

We have at our mine several B. & W. boilers with cast-iron headers, and after a boiler has been shut down for cleaning, on starting it up again we sometimes find a cracked header. This we think is due to unequal contraction or possibly expansion, as we have never had a header fail while under pressure. In the iron mines, as a rule, the boiler plant is worked to its full capacity with no spare boilers, every one being in use; so when a cracked header is found, it means a "hurry-up job" to get it back in service.

After making a great many different kinds of tools to remove a broken header without removing the tubes, we have adopted the set shown in the illustration and proceed as follows:

All the caps are removed from the header, then the header breaker is put in and the tapered drifter pin driven in the square hole in its center until the header breaks, the operation being repeated at each handhole. Then with the long chisel any pieces that cannot be drawn over the end of the tube are broken up. The next operation is swaging the flared end of the tube back to its original size, which is done in the following manner: The flue heater is heated in a portable blacksmith's forge, or it may be heated in the furnace of another boiler. When hot, it is placed on the inside of the tube end and to increase the heating effect the sheet-iron funnel filled with burning oil-saturated waste is hung on it, and the tube will soon be brought to a red heat. The tube-shrinking ring is then placed over the tube and the mandrel used to force the ring on by



TOOLS FOR REMOVING BROKEN TUBE HEADER

striking it lightly with a hammer; this quickly reduces the tube to its original size. Then wood blocks are placed between the tubes to keep them the right distance apart, and all is ready to put in the new header. If the job is done in this way, no new tubes are required. THOMAS J. PASCOE.

Norway, Mich.

It would help the fuel situation a bit if the street lamps in American cities were turned on when it grows dark enough to need them and not three-quarters of an hour before that time each day.

Inquiries of General Interest

Steam Required for Atomization of Fuel Oil—For atomization of fuel oil, what quantity of steam is required per pound of oil atomized? B. H. D.

The steam required to atomize the oil varies from 0.3 to 0.7 lb. per pound of oil. The average consumption is about 0.5 pound.

Overheating of Clean Water Tubes—What causes burning, bagging or blistering of tubes of water-tube boilers below the water line when the tubes are made of good material and clean of oil and scale? J. T. M.

A water tube may become burnt, bagged or blistered when, from forced firing or poor circulation, the water of the boiler is driven or held away from the tube surface by the steam that is generated, thus permitting the tube to become overheated.

Setting Steam Valves of Duplex Pump—What is the simplest method of setting the steam valves on a duplex pump? W. N.

Place both pistons in the center of their travel; the rocker arms will then be plumb. Remove the steam-chest cover and place each steam valve centrally over the ports, and adjust lost motion equally on each side of the collars or nuts that move the valves. Before replacing the steam-chest cover, move one of the valves so as to open a steam port and thus enable the pump to start up when steam is admitted to the steam chest.

Holding Safety Valves During Hydrostatic Test of Boiler—The pop safety valve of a boiler is set to blow off at 100 lb. pressure. What should be done to the valve so as to obtain a test pressure on the boiler of 150 lb. per square inch? B. B. T.

During a hydrostatic test the safety valve or valves of a boiler should be removed with the connection temporarily blanked off, or each valve disk should be held to its seat by means of a testing clamp. Most manufacturers of spring pop safety valves furnish a special testing clamp, or "gag," for the purpose. The valve should not be held closed by screwing down the compression screw upon the spring, as that would be likely to injure the spring.

Kilowatt Output of Alternator—What is the actual kilowatt output on an alternator when the ammeter reads 300; power-factor meter, 0.82; and the indicating kilowatt meter, 1360? W. C. C.

The ammeter reading and the power factor are not necessary to be taken into account, as the kilowatt output of the machine is that registered by the kilowatt meter; namely, 1360. If the number of phases and voltage were given, it would be possible to check the correctness of the meter readings. For a two-phase machine the kilowatt output is equal to volts per phase $\times$ amperes per terminal $\times$ 2 $\times$ power factor $\div$ 1000; and for a three-phase machine the output would be volts per phase $\times$ amperes per terminal $\times$ 1.732 $\times$ power factor $\div$ 1000.

Size of Conductors for Two-Phase Motor—How is the size of the conductors, 200 ft. long, determined for a two-phase four-wire 50-hp. 220-volt motor? I. C. B.

The full-load current required per terminal by the motor is generally given on the name-plate, but can be determined approximately by the expression, hp. $\times$ 1000 $\div$ volts $\times$ 2, in this case amperes = 50 $\times$ 1000 $\div$ 220 $\times$ 2 = 114. The National Board of Fire Underwriters' Code states that the carrying capacity of conductors for alternating-current motors requiring over 100 amp. per terminal must be 150 per cent. of the normal full-load current rating of the motor; in this problem, 114 $\times$ 1.50 = 171 amp. For a rubber-covered conductor the wire table gives a No. 000 B. & S. as the correct size. This size conductor for alternating-current motors can be fused up to the rating for other insulations or 275 amp. The resistance of 400 ft. of No. 000 copper wire is 0.025 ohms, and the volts drop in the line at 50 per cent. overload is, current $\times$ resistance = 171 $\times$ 0.025 = 4.3 volts, which is well within good operating practice.

Short-Circuit Secondary of Current Transformer—Why is it necessary to short-circuit the secondary terminals of a current transformer when they are disconnected from the device the transformer is serving? E. K. P.

The iron core of a current transformer under normal conditions is worked at a very low magnetic density, consequently the flux will build up very rapidly as the ampere turns increase, if their effect is not neutralized in some way. When a current transformer is under normal load, the ampere turns in the secondary are almost equal to those of the primary, therefore the effective ampere turns, and likewise the flux and voltage, are at a low value. However, if the secondary circuit is opened, when the transformer is loaded, the total primary ampere turns are effective in setting up a flux, which reaches a high value, likewise the voltage in the winding. The latter in many cases become of a value that will break down the insulation and destroy the transformer. A current transformer operating with its secondary open-circuited also acts as a choke coil in the line. By short-circuiting the secondary terminals, when they are disconnected normal conditions are maintained in the transformer.

Heating Feed-Water at Expense of Back Pressure—In a steam plant operated at 100 lb. boiler pressure, a closed type of exhaust-steam feed-water heater delivers the boiler-feed water at 205 deg. F. with 2 lb. back pressure on the exhaust of the engine. Would it not be more economical to raise the temperature of the feed water to 212 deg. F. by increasing the back pressure on the engine? W. C. C.

If the only heat recovered out of the exhaust is that utilized by the heater in raising the temperature of water required for generation of steam supplied to the engine, then it would be detrimental to economy to increase the temperature of the feed water at the expense of increasing the back pressure. The temperature of the exhaust at 2 lb. back pressure above the atmosphere is about 219 deg. F., and to increase the feed-water temperature to 212 deg. F. or 7 deg. higher would require the exhaust to be at a temperature of about 226 deg. F. corresponding with about 4.5 lb. per sq.in. above the atmosphere, or an increase of 2.5 lb. back pressure; and with the same load the consumption of steam by the engine will be increased practically as though the load had been increased to require 2.5 lb. additional m.e.p. Allowing the required m.e.p. to be 50 lb. per sq.in., the increased steam consumption would be about 5 per cent. A pound of steam at 100 lb. gage, or 115 lb. absolute, contains 1188.8 B.t.u. above 32 deg. F. and generated from feed water at 200 deg. F. requires 1188.8 + 32 — 200 = 1020.8 B.t.u. With the feed water at a temperature of 212 deg. F. obtained with 4.5 lb. back pressure, each pound of steam generated would require 1188.8 + 32 — 212 = 1008.8 B.t.u.; but 1.05 times, or 1008.8 $\times$ 1.05 = 1059.2 B.t.u. would be required for performance of the same work as obtained from a pound of steam with only 2 lb. back pressure, so that increasing the back pressure to raise the feed-water temperature from 200 to 212 deg. F. would be attended by requirement of (1059.2 — 1008.8) $\times$ 100 $\div$ 1008.8 = 4.9, or practically 5 per cent. more fuel for developing the same power.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—EDITOR.]

Preventable Waste of Coal in the United States*

By DAVID MOFFAT MYERS†

By employing proper operating methods in boiler plants it is easily possible, according to the author, to save at least 10 per cent. of the coal now burned for steam-making purposes. Such a saving would release cars for other service equivalent, say, to the coal-carrying capacity of the Pennsylvania Railroad lines east of Pittsburgh, equal to 1,000,000 fifty-ton carloads per year, and the direct money saving to the industries would be around a quarter of a billion dollars, figuring the coal at $5 a ton. Discussion on the paper appears in this article.

As a means of far-reaching economy the Government of the United States should at this time apply intelligent and direct-acting efforts to the conservation of fuel at the industrial plants which are responsible for its greatest consumption.

The mining and distribution of the coal have been placed under the supervision of the War Coal Board in order more nearly to meet the crying needs in these directions, to use the railroad facilities more efficiently so that the present car shortage may be minimized and to apportion the coal in quantity and to uses deemed most expedient.

While this organized effort to bring about efficiency in the production and distribution of coal is being made, no parallel measures have been adopted to bring about a normal and practicable efficiency in its use. The hundreds of large plants which are consuming fuel wastefully, in many cases more wastefully and carelessly than ever before, are directly and needlessly causing a large fraction of the existing car shortage.

Preventable Waste of Fuel

The preventable waste of fuel in the boiler furnace of one steel mill which I investigated amounted to 40,000 tons per year, which at $5 a ton would cost $200,000. This was a comparatively modern plant. The efficiency of boilers and furnaces in a 14-day test was 55 per cent. The load factor was unusually favorable to high efficiency and could readily be raised to 70 per cent. or over. This is only one example, and there are many more extreme cases. In one hand-fired plant the evaporation was raised from 6 to 9 lb. in a few days of instruction and continuously kept close to this higher mark with the help of coal and water measurements which were inaugurated. The saving was due exclusively to instruction and consequent better operation.

The saving or wasting of one-fourth of the coal consumption of any industrial plant depends entirely upon the efficiency of its operating management. Let me emphasize that this fraction of the consumption relates exclusively to the *boiler* plants, that is, the production of steam, and does not include the large economies possible in connection with its distribution and use.

For well-known reasons the boiler plant offers the more lucrative field for producing economies, and these with a minimum of alteration in physical equipment.

Under present conditions a plant which carelessly operates at an efficiency of 40 to 50 per cent. receives from the Government the same consideration in the delivery of coal as the one whose efficiency is 70 to 75 per cent. This obviously is unfair and wasteful.

The Government hands over, say, 200,000 tons of coal a year to a plant owner, but asks for no accounting as regards its consumption, nor any questions as to the amount of steam it is made to produce.

There is no doubt that very important economies in the use of food have already been effected by educational campaigns. These economies are largely the result of educating the ultimate consumer. The requisite propaganda does not attempt to teach the intricacies of food chemistry or the complex action of the gastric juices.

The object of this paper is to open a discussion which, it is hoped, will ultimately lead to the formulation of definite fuel conservation recommendations, to forward these recommendations to the proper governmental authorities as an official communication of this society, and to offer to the Government the services of the society for the organization, furthering and, as far as possible, the execution of the plan which may as a consequence be adopted.

There are, I think, two plans of operation worthy of consideration. The one might be termed the autocratic method. This would involve the use of authority to compel coal consumers to execute such measures of economy as the proper authorities might prescribe for any given case, limits to be set as to expense to the user. Such limits might be in terms of a percentage of his present yearly coal bill. Alterations should be directed chiefly, as previously implied, to purely operating improvements. Many objections would probably be made by consumers against this plan, but once in effect the majority would no doubt realize its pecuniary advantage to themselves. But its tendency may be too strongly opposed to democratic principles.

The other plan would be largely an educational one, in which patriotism and efficiency would furnish the motive forces required. The teaching must be accomplished with the utmost simplicity and directness. Above all it must be in such form as to be readily comprehended and applied.

The requisite information must reach the owners and managers of industries, and there must be simple instruction sheets for the engineers and firemen. The vital importance of daily accurate records of coal and water must be taught and information given regarding practical appliances for automatic measurements of both.

Blank forms might be sent in advance to plant owners in order to be advised by them, first, whether they would be willing to coöperate with a governmental organization offering to assist them in reducing their coal consumption, and second, to obtain such data as to size, type, equipment, operation and fuel consumption of the plants as would enable a classification that would permit a government board of experts to send such instructions as would include the information needed for any one class of plants.

This work would be very greatly aided by a staff of experts ready to visit plants when so requested by owners, and make investigations and recommendations and keep in touch with the progress of economies. Included in such a staff must be men intimately familiar with practical operating economies, whose duties would be the delivering of lectures or talks which should be planned so as to reach directly not only managers and owners of the industries, but also the chief engineers and firemen of the boiler plants.

TABLE I. TOTAL COAL PRODUCTION, BITUMINOUS, LIGNITE AND ANTHRACITE, YEAR 1915

	Net Tons	Per Cent.
1. Bituminous and lignite	443,462,509	85.2
2. Anthracite	76,906,431	14.8
3. Total	520,368,940	100.0

The United States Bureau of Mines has for a number of years engaged in obtaining and disseminating scientific information regarding the mining and consumption of coal, and the results of the work have been of great value to technical engineers who are able to use and apply it.

Six hundred million tons of coal was mined in the United States last year. It is predicted that 700,000,000 tons will be mined this year, and next year's production will likely be still greater. Of this quantity approximately 67 per cent., or 469,000,000 tons, will be burned for steam-making

*Presented at the annual meeting, December, 1917, of the American Society of Mechanical Engineers, New York.

†Consulting engineer, New York City.

purposes on land, assuming the same percentage consumption for steam production as existed in the year 1915.

The saving or wasting of one-quarter of this coal, that is, over 117,000,000 tons, depends on the efficiency with which we operate our boiler furnaces. If we actually saved by proper methods only 50,000,000 tons per year, this economy would result in freeing for other important service the use of 1,000,000 fifty-ton freight cars per year. The significance of such an economy may be realized when it is stated that the number of cars thus released for other service would be equivalent to 15 per cent. more than the combined yearly coal-carrying capacity of the Baltimore & Ohio and Southern Railway systems; approximately equal to that of the Pennsylvania R.R. system on lines east of Pittsburgh, or 1⅞ times the number of coal cars hauled by the Norfolk & Western. The direct saving to our industries would be $250,000,000 worth of coal per year, if figured at $5 per ton.

TABLE II. PERCENTAGE DISTRIBUTION OF BITUMINOUS COAL AND LIGNITE PRODUCED IN THE UNITED STATES AND IMPORTED IN 1915, BY USES

		Per Cent.
1.	Railroad fuel	28.0
2.	Steamship bunker fuel—tidewater	2.0
3.	Steamship bunker fuel—Great Lakes	0.3
4.	Manufacture of beehive coke	9.3
5.	Manufacture of byproduct coke	4.3
6.	Manufacture of coal gas	1.0
7.	Domestic and small steam trade	16.0
8.	Industrial steam trade	33.0
9.	Exported	4.0
10.	Steam and heat at mines	2.0
11.	Special uses	0.1
12.	Total bituminous and lignite	100.0

NOTE.—Imports were only a little over one-tenth of one per cent. and are therefore neglected.

No information is available for complete classification of the distribution of the anthracite, but it is estimated in report on "Coal in 1915"* from which Tables I and II are made, that 50,000,000 net tons of anthracite were used in 1915 for "heating households, apartment houses, hotels, and office, school and other buildings." This leaves about 27,000,000 net tons or 35 per cent. for industrial uses, principally steam making. If we eliminate households we may assume that 25,000,000 tons of the 50,000,000 tons are used for making steam, so that of the total 77,000,000 tons of anthracite we may say that 52,000,000 tons, or 67.5 per cent. are used for steam production.

* "Coal in 1915," by C. E. Lesher, published by the U. S. Geological Survey; Part A on production, Part B on distribution.

This saving would be $\frac{50,000,000}{469,000,000} = 10.65$ per cent. of the coal now burned for steam production. It is impossible to state the present average efficiency of boilers and furnaces, but I have personally spent sixteen years of concentrated study in the investigation and improvement of steam and fuel conditions in factory power plants, and I have never visited a plant of this class where a saving in coal of at least 10 to 12 per cent. could not easily be made. The poorer the conditions found the easier it is to make an attractive saving in fuel.

Table IV shows to what point the efficiency of a plant must be raised to obtain the saving of 10.65 per cent. upon which these economies are based. The poorly run boilers would of course be susceptible to the greatest improvements. Hundreds of boiler plants operate at no greater than 58.07 per cent. efficiency, and it is a comparatively simple matter to bring them up to an efficiency of 70 per cent. or higher. The latter would result in a saving of over 17 per cent. of the coal.

TABLE III. COAL USED ON LAND FOR STEAM PRODUCTION IN PERCENTAGE OF TOTAL PRODUCTION

		Per Cent.
	Bituminous:	
1.	Railroads, item 1, Table II	28.0
2.	Domestic and steam trade, assume only one-quarter of item 7, Table II	4.0
3.	Industrial steam trade, item 8, Table II	33.0
4.	Steam and heat at mines, item 10, Table II	2.0
5.	Total bituminous	67.0
	Anthracite:	
6.	To steam making	67.5

Hence it may be assumed that 67 per cent. of all the coal produced is used for making steam on land.

To save 10.7 per cent. of the coal consumption necessitates the raising of any combined efficiency of boiler and furnace from that shown under Old Efficiency in Table IV to the corresponding value under New Efficiency in the same table.

If we do not limit our action to coal used for steam generation, but extend it to include economy with which the steam itself is utilized and applied, the predicted saving could be doubled, so that we might save 2,000,000 fifty-ton carloads of coal per year. There is, for instance, widespread ignorance to a surprising degree in regard to the value of exhaust steam in heating and process work. The coal-consuming public should be taught that a heating system which requires 100 boiler horsepower may insert a steam engine between boiler and heating main and obtain nearly 100 mechanical or electrical horsepower in addition to the required heating for about the same consumption of fuel.

TABLE IV. INCREASES IN COMBINED EFFICIENCIES OF BOILER AND FURNACE NECESSARY TO EFFECT A 10.7 PER CENT. SAVING IN COAL

Old Efficiency, Per Cent.	New Efficiency, Per Cent.	Old Efficiency, Per Cent.	New Efficiency, Per Cent.
44.67	50	62.54	70
49.14	55	67.00	75
53.60	60	71.47	80
58.07	65	.....	.....

Saving of coal with same output of steam

$$= \frac{\text{New Efficiency} - \text{Old Efficiency}}{\text{New Efficiency}}$$

and

Increase of steam production for same coal

$$= \frac{\text{New Efficiency} - \text{Old Efficiency}}{\text{Old Efficiency}}$$

Steam plants are under the immediate management of chief operating engineers. The examination requirements for licenses in this profession call for practically no knowledge of steam and fuel economics. These examinations deal chiefly with matters of safety, repair and maintenance of equipment and neglect almost entirely the subject of coal economy. This is a very serious defect in our present system and is directly responsible for a large preventable waste of fuel.

The mining and distribution of our coal supply, the regulation of prices and the adjustment of financial and labor problems have already been placed under official administrative attention. But no parallel measures have been adopted looking toward reduction of waste in connection with the utilization of this coal.

Discussion of the Paper

Walter N. Polakov: The invitation to discuss the means and methods for reducing waste of coal is very welcome since all that has been said and done so far has failed to produce tangible results.

Last April I brought out the impending danger of a fuel famine and soon afterward the movement was on the way affecting at that stage only coal production, transportation and prices.

Being limited in its scope and nature, it did not embrace at that time the third group of my original recommendations concerning the use of fuel. My editorial in *Coal Age* of July 14 and articles in other magazines[1] emphasized this paramount task "to start at once the movement for the efficient utilization of every available supply of fuel."

A couple of months later Mr. Garfield publicly admitted that the principal hope for a solution of the coal problem lies with the people themselves: "They must save every possible bit of fuel."

Saving may be carried out along two lines—either on the principle of German "Spar Kasse," inevitably limiting the industrial productivity and impairing the health of the people, or on the principle of more efficient utilization of fuel, producing more power and heat with less coal. Only this latter means of saving is to be considered.

The inauguration of efficient management of power plants cannot be accomplished overnight. It requires study in each plant of its peculiar conditions. It requires careful training of firemen and other employees. It necessitates an adequate stimulation of employees to continually maintain the highest degree of efficiency. To do it no capital investment is needed. It is not a matter of better furnaces, of mechanical stokers, or other cures preached by salesmen. It is a matter of knowledge and method.

There are already many plants that have reduced their coal consumption from 20 to 40 per cent. for the same output, by better organization of power-plant work. There is no need to here describe these principles and their results. "Task Setting for Firemen," a paper presented before this

[1] "Industrial Management," May, 1917, September, 1917; "Literary Digest," June 15, 1917; "Utilities Magazine," September, 1917.

society in 1913, "Planning the Power Plant Work," a paper delivered before the Taylor Society, and numerous other contributions describe the nature of my work and fundamental principles more or less at length. Van H. Manning, Director of the Bureau of Mines, recently took the view advocated by me for years. Said he: "The immediate problem is a difficult one. We cannot scrap all out-of-date power plants. We must start by doing the best with what we have. We must begin saving coal at once. The problem is a personal one. It deals with the human elements. We must reach the man with the shovel."

Mr. Myers presents for discussion two plans. The first one is unfortunately worded so as to create prejudice against it. It reads ". . . . the use of authority to compel coal consumers to execute such measures of economy as the proper authority might prescribe in any given case." It sounds Prussian. But is it? Does it mean imperialistic, arbitrary authority or an authority of an expert based on scientific knowledge of facts, similar to the authority of a doctor prescribing treatment?

The strength of England, France and even the Central Powers is due to the coöperation in industries. Those who fail to render the service to the common cause are denied the privilege to mismanage their plants. True enough, this coöperation is regulated by the state and at times compulsory as is conscription or commandeering of productive facilities or commodities. The voluntary coöperation for which we long will come only after the war as a result of new social readjustments. But we cannot wait. The problem is of today. Tomorrow may be too late.

In other words we must create conditions stimulating voluntary coöperation even under individualistic regime.

The plan therefore means the abolition of privilege to waste fuel in inefficiently conducted plants, by giving priority in coal deliveries to those who prove that they do not use it efficiently.

At present a wasteful plant gets an excessive amount of coal, while the highly economical one stands an equal risk of being shut down for the lack of coal. If the efficiency is protected by priority, it will work also as a stimulus for the wasteful ones to find means to improve their methods and then ask for a new rating.

Such encouragement of efficient plants, rendering good service to the country and stimulating the inefficient to seek their salvation through the means beneficial to the country can be accomplished along the following lines:

Rating by experts (nominated by the national engineering societies and supported by public opinion and Government) of plants in the indispensable industries who are entitled, because of coal-saving methods in use, to the priority in coal supply.

Receiving of applications by the special service bureau of American Society of Mechanical Engineers, from the low-rated plants for assigning the expert help.

Serving the needs of such inefficient plants by offering services of recognized experts in power-plant management for direction of the work.

Organizing a staff of steam, electrical and combustion engineers, whose members will be assigned to carry out the work in the plants of the applicants under the direction and supervision of experts.

Charging for such services an adequate compensation to cover the expenses involved (salaries, traveling and office) but no profit.

Mr. Myers' second plan, "an educational one, in which patriotism and efficiency would furnish the motive forces required," is in my opinion doomed to failure for the following reasons:

Teaching efficiency by a correspondence-school method will accomplish little good, is incompatible with the professional dignity of this society and lacks the personal touch.

Endless variety of equipment, grades of fuel available, personality of men, nature of load, climatic conditions, etc., make the preparation of "simple instruction sheets for engineers and firemen" impossible and if made they are so general as to be useless. Failure of the Massachusetts fuel board in such an attempt is a joke among power-plant men in that section.

No instructions of real value could be given unless examination of the plant was made. Selling patent medicines curing all diseases ranks with fake only too often not to make one careful.

Keeping records, logs, etc., necessitates instrument equipment and measuring devices; all of this is good only when the data are used and interpreted by a trained man and this is done continually. Too many plants have no instruments at all; most of those that have, keep them as ornaments owing to the lack of proper organization.

If the regular employees failed to secure high efficiency it is not because of the lack of "circularized education" but chiefly on account of lack of time to carry on investigations and tests all the time being absorbed by routine duties; absence of instruments, facilities or encouragement; lack of experience in this highly specialized line of research work.

The education must begin with owners and managers, not with the firemen.

The very principle of "teaching" and "instructions" given to manufacturers and plant owners by the society is undemocratic and unamerican. They do not want or need "to get something for nothing." Producing for the country but not without profit they can prefer to pay for what they get if the benefit is commensurate with the expenses.

"Educational" talks and circulars usually degenerate rapidly into debating societies, wasting time needed for deeds.

Any half-measures with good intentions falling short of accomplishing valuable results are dangerous as they chloroform the public conscience, creating a belief that something real is being done while there is little behind the words that make all content.

To sum up, the problem is to be solved by groups and individuals availing through this society to the services of those who know how more power can be gotten out of a pound of coal. There is no necessity to compel plant owners to improve their methods since in such a step lies their self-preservation. But there is an urgent necessity from the national viewpoint to conserve the fuel by preventing its waste by ignorance or indifference. The valuation of plant methods to establish ratings for priority in coal deliveries is therefore recommended.

Albert A. Cary: Mr. Myers endeavors to focus our minds upon this panacea in the statement that "the saving or wasting of one-fourth of the coal consumption of any industrial plant depends *entirely* upon the efficiency of its operating management," and this seems to be the text upon which the balance of his paper is founded.

To secure the desired conservation of fuels in such plants, Mr. Myers advises the services of the expert in operating management. Provided he understands his business, such an expert can undoubtedly secure desirable fuel savings; but results depend largely upon the coöperation he receives from the plant owners and their employees, as well as their willingness to equip plants with the needed apparatus and to use them continuously after the expert concludes his work.

To illustrate, I will refer to the plant of one of my clients, the Tennessee Copper Co. By redesigning the furnaces in this plant and adapting them to the fuel used and by substituting machine-fired grates, they have since succeeded in obtaining the same amount of steam with but 64 per cent. of the Jellico coal formerly used. This plant, when completed, was turned back to the same management that it had before with no further instructions. There were installed facilities for continuously determining the weight of the coal, ash and water used as well as the analysis of the furnace gases.

In another large industrial plant a similar saving in coal was effected. This plant has an aggregate capacity of over 7000 nominal boiler horsepower, divided into 22 units. It was formerly operated with hand-fired shaking grates for which machine-fired grates were substituted with properly designed furnaces. The plant is now being operated continuously at 150 per cent. rating and is using no more fuel than it formerly did when being operated at two-thirds of its present output. The boiler-room force required to operate this altered plant is less than half of the number of men formerly required. No change has been made in the management of this plant.

Proper furnace design and construction, flue and draft-

producing equipment adapted to the use of the particular kind or quality of fuel used is the keynote of the question of fuel conservation.

Furnish the mason with complete instructions for "laying up" the brickwork and properly bonding the interior and exterior walls of the furnace so that the large difference in temperature between the two sides will not, by unequal expansion and contraction, rapidly destroy these furnace inclosures and so waste fuel by infiltration of air.

The selection of material used and its method of erection should never be left to the mason, as it is safe to say that fully 90 per cent. of the masons erecting furnace settings are hopelessly unqualified to produce a proper setting. After equipping the plant with proper furnace settings which are adapted to produce the highest possible efficiency with the particular fuel available, the expert in operating management can come into the plant to instruct the men.

To meet the present emergency, I propose that the War Coal Board bring all the firemen in this country under its control by requiring them to take out United States licenses. The various state, county or municipal governments can assist them in this work. The applicants for these licenses must show some qualifications that would entitle them to hold such privileges, but it is doubtful whether it would be possible, at the beginning, to have all these applicants examined before qualified examination boards.

Future applicants should be required to pass an examination before such boards and qualify in a satisfactory manner before receiving their licenses. Any operator of a coal-burning plant (domestic plants, of course, excepted) who operates his equipment without a licensed fireman should be liable, first to fines and finally to more severe penalties.

Each license should be issued for the applicant to operate in a definite, described plant and nowhere else. Should the fireman leave this plant for any good reason, rather than for incompetence, he can take his license to the proper authorities and have it transferred to another plant where he has found reëmployment.

Should the fireman be found to be incompetent, his license should be revoked and future applications be denied.

Inspectors appointed by the War Coal Board might visit from time to time the various coal-burning plants, and should they find any of them using fuel wastefully, a notice should be served upon the owner. If this is not followed by prompt action to reduce or stop the waste, the fireman's license should be revoked.

The foregoing is proposed as a war measure.

Professor L. P. Breckinridge told of the methods used in Connecticut to conserve coal, stating that meetings were held to which the public was invited, to be told how to burn coal economically in house and power-plant boilers. Norman Reinicker believed that fuel economy was much more a matter of design than education of firemen. E. N. Trump emphasized the value of bonuses to firemen to give incentive for economical use of coal.

Utilizing Surplus Electrical Energy for Generating Steam*

BY F. HOEHN

An interesting test was conducted by the Swiss Society of Steam Boiler Owners to determine the commercial possibilities of generating steam for heating purposes by electricity. The plan proposes the heating and storing of the proper volume of water under pressure, from which the steam was to be generated by expansion to a lower pressure on the principle of the fireless locomotive.

A small model tubular boiler 24 in. in diameter and 50 in. long containing thirty-eight 1¼-in. steel tubes was used for the test. Glass-insulated microhm heating coils having a resistance of 1.1 ohms were inserted in 34 of the tubes and so connected that the latter were divided into three groups of 18, 9 and 7 respectively, any of which could be cut out of service. Direct current at 225 volts obtained from a hydro-electric plant on the premises was applied.

*Translated from "Schweizerische Bauzeitung."

The following table gives the results of two tests:

	Test No. 1	Test No. 2
Duration, hours	7.6	7.0
D.C. voltage	225.8	225.6
Average amperes	142.4	148.8
Average kilowatts	32.2	33.6
Average pressure, lb. per sq.in. abs.	25.0	29.4
Average temperature, deg. F.	51.8	50.0
Total heat in one pound of steam, B.t.u.	1,160.0	1,163.4
Total evaporation, lb. per hour	85.5	89.7
Evaporation in pounds per square foot of heating surface at minimum demand	2.7	2.42
Evaporation in pounds per square foot of heating surface at maximum demand	2.85	2.68
Evaporation in pounds per square foot of heating surface at average demand	2.76	2.62
Total pounds steam generated per kw.-hr.	2.65	2.67
Theoretical heat in B.t.u. per kw.-hr.	3,415.0	3,415.0
Actual heat obtained in B.t.u. per kw.-hr.	3,074.0	3,106.3
Efficiency, per cent	90.0	90.9

The efficiency of 90 per cent. might have been improved by better lagging, as most of the losses were due to radiation.

It is interesting to note that the evaporation per square foot of heating surface was greatest at minimum demand, owing to the better heat transfer to the water when the latter was not filled with steam bubbles. For practical purposes it is fair to assume a mean evaporation of 2.46 lb. per sq.ft. of heating surface.

The first requisite for steam generation by electricity is a cheap source of power. In order that such a system may compete with a coal-fired plant, with coal selling at $8.75 per ton in Switzerland and an average evaporation of 7 to 8 lb., the author computes that the cost of current cannot exceed 0.16c. per kilowatt-hour.

Such low-cost current is rarely obtainable. However, cases may arise where an otherwise partly idle hydro-electric plant can be used to furnish the necessary current on nights, Sundays and holidays. If, then, sufficient heat can be stored in the water to furnish steam by regeneration for the entire week, the practical application of this method takes on an entirely different aspect.

The author derives a number of equations for computing the heating surface and the storage space required for furnishing the maximum amount of steam for heating purposes at a reduced pressure of 22 lb. absolute, with an available power supply of 883 kw. for 12 hours.

Given a feed temperature of 59 deg. F., the total steam obtained at a mean pressure of 99 lb. is shown to be 2244 lb., which would require about 80 sq.ft. of heating surface. The total amount of water necessary amounts to 20,661 lb. and would require a storage space, making due allowance for extra steam space of some 400 cubic feet.

Placing the radiation losses at 6 per cent., the total amount of steam reduces to 2109 pounds.

With an evaporation of 7.5 lb. and coal at $8.75 per ton, this represents an equivalent fuel cost of $1.23 per day, or $369 per year of 300 working days, an amount which the author believes sufficient to cover the interest and depreciation of the simple equipment required.

The system offers the advantage of high efficiency in transforming the surplus electrical energy into heat with only slight storage losses and to give up this heat at any rate desired while requiring only nominal attention. It may also become the means for improving the load factor of the plant by cutting in the heating coils as the load decreases.

Heating Houses with Gas

As a producer of heat units on the generous scale for such service as house heating, manufactured city gas has not been able to compete with coal, says E. D. Milener, in *American Gas Engineering Journal.* Even with gas at 35c. a thousand cubic feet and coal at $8.50 a ton, the average fuel cost of heating an entire house with gas will be at least 25 per cent. more than with coal, and to keep this difference from being greater it is necessary that the best equipment only be used and proper attention given to its operation. A three-story cottage equipped with a gas-fired steam-heating system consumed, during the eight months from October to May, 465,800 cu.ft. of gas. The lowest monthly consumption, during October, was 23,700 cu.ft., and the highest, during February, was 88,700 cubic feet.

Engine-Room Management in the Ice Plant*

By EDWARD N. FRIEDMAN†

The author does not condemn the high-speed ammonia compressor; but believes more accurate performance data and more knowledge of how these machines "stand up" under everyday service are needed to warrant their wide and rapid adoption. Several hints on engine-room management follow.

WE HAVE not exactly been told, but it has been intimated, that anybody not using the new high-speed compressors and electrical drive or uniflow engine is a back number; that this or that certain system of raw-water ice with or without core-suckers is the only system to use; that only synchronous motors with direct drive show that a plant is up to date; that this or that filtering system does away with water softening; that this or that water softener does away with filters, etc., etc.

There are scarcely any reliable test data available as to the actual performance, and particularly as to the lasting qualities, of the high-speed compressor under various conditions. They have not been in use long enough to judge whether the claims for them are justified. I am as much in favor of progress as anybody, but I feel that far more information about actual performances must be gathered. I know that a number of plants have been installed, but not enough data have been established yet to remove all doubt that the slow-speed compressor must go. Two reasons for favoring the high-speed compressors against the old-time slow-speed are usually given; namely, the smaller space required and the cheaper first cost. I find, however, that the second reason is not in accordance with the facts. Some of the new high-speed compressors cost more than the slow-speed of the same capacity, and I cannot see why.

Separate Cooling of Liquid Ammonia and Water

One thing, however, has been done lately to a greater extent than before, and that is the separating of the cooling of the liquid ammonia and the water from the general system, using a separate compressor running under higher back pressure, which means higher economy, as I shall try to explain later. This, of course, has nothing to do with the high-speed compressor or the uniflow engine, but is the outcome of the installation of the raw water system, since without that system the question of economy is mainly a question of the boiler-plant economy.

This also refers to the question of superheaters for the steam. Since, however, we all are not ready to put in new machinery and since we have to get along with what we have, let us see how we can arrange things to get the best results out of our present plants.

Any ordinary ice plant consists of boiler plant, engine-room equipment, condenser floor and ice-tank storage room. Each of these things is important and essential to the plant, but the main question is whether these different parts are built of sizes or capacities to work with the other parts to the greatest advantage for the final purpose. There must be a certain relationship as to the size of compressors, the number of cans and amount of piping in the tanks, the size and amount of piping in the water forecooling tank and the size of the ice-storage room. Any mistake in sizes and arrangement of any one of these items means a drawback and lack of economy.

If, for instance, the size of the distilled-water storage tank is too small, it means losses of water during lunch hours. If the amount of piping in tanks is too small, it means lower back pressures to obtain lower temperatures, a decidedly uneconomical feature; if there are not sufficient cans, the same argument holds good; if the condenser capacity is too small, it means higher condenser pressure and higher power consumption per unit of output, whether steam, electrical or any other kind.

If the storage room is too small, it means trouble during the hot season and the danger of being induced to draw ice ahead to meet the Saturday demand and then have no ice for Monday, which may be a hotter day than Saturday. It would take too much time to go into every detail of ice-plant construction. I must confine myself to the management of the plant, which may be assumed to be reasonably well constructed and proportioned, and here again I must confine myself to the engine room, in accordance with the wishes of the committee in charge of the program.

You will notice that when a test has to be made of the capacity and economy of the plant, the thing that invariably happens is the surprising number of data that have to be carefully recorded. Evidently, it is needed to establish the best way of running, and it is also remarkable that the employees, knowing that these data are being taken, suddenly seem to realize that they must try to be more regular, even pay more attention to oiling, pumps, etc., feeling that if something goes wrong, the professors making the test will find it out somehow and quickly, and there will be the deuce to pay.

Tuning Up the Machines for the Test

Before the tests start, the machines are "tuned up," minor repairs are made and the condensers are cleaned; in other words, the plant is put in proper condition for the test, with the expectation that this will produce better results and save the men from being accused by the party making the test of being careless or incompetent. Since a test is made to prove the best results, it must logically be the aim of the owner to produce as nearly as possible the same results all the time. Therefore, if the keeping of data tends toward better results, why not keep the same data and records all the time? I do not mean that readings should be made and entered every half-hour, as during a test, but say every two hours, or even every four hours. The mere fact that such data as condenser pressure, back pressure, water and brine temperatures must be entered at certain hours makes it necessary to pay more attention to these matters, with consequent better handling. Furthermore, it shows the night man the condition the plant was in when turned over to him.

I have found that on the average log the only things recorded are the number of cans of ice pulled and the temperature of the brine in the freezing tanks. Since it is, as a rule, rather difficult to read thermometers correctly, considering that in many cases the instrument has to be pulled out of the brine to get sufficient light, I have always advocated the installation of recording thermometers. I cannot make the point too strong that I believe it is impossible to run a compressor in the best manner without the use of thermometers; that is, without having a thermometer in both the suction and the discharge line. One might as well tell the engineer to maintain 100 lb. steam pressure, yet give him no steam gage. The object of thermometers is particularly to prevent too much liquid entering the compressor, since that liquid has circulated without doing any useful work. I cannot go into further details, but would suggest giving the engineer a table such as the following to guide him in handling the gas:

Gage Pressure, Lb.	Boiling Point, Deg. F.	Temperature at Which Suction Gas Enters Compressor, Deg. F.
12.25	—3	+3
15.67	0	+7
19.46	+5	+11
23.64	10	+16
28.24	15	+20
33.25	20	+25
38.73	25	+28
44.72	30	+33

If, for instance, the gage shows 20 lb. back pressure, then the thermometer in the suction line should show about +11

*From a paper before the Eastern Ice Association, Atlantic City, November, 1917.

†Consulting engineer, 90 West St., New York City.

deg. F. Then little or no liquid will go into the compressor. If the suction gas is handled rightly, the discharge gas will take care of itself. At the same time it might be well to give them also a short table as a hint how these temperatures usually run. This table is based on tests:

Back Pressure, Lb.	Single-Acting Compressor, Deg. F.	Double-Acting Compressor, Deg. F.
5	260	295
15	240	287
25	213	253

This is assuming cooling water of 60 deg. F. initial temperature. If temperature is higher, add the difference to figure given; for lower temperature deduct, etc. I have found, and quite naturally so, that the average engineer has not been told enough by the contractors furnishing the outfit, therefore even as small a table as the one given will help him.

It is also advisable to provide an indicator for the engineer and make sure that he uses it on the steam engines as well as on the compressors. Diagrams should be taken at regular intervals, say every two weeks, even if everything is apparently working all right.

I wish to call attention to the method, in many plants, of using the return gas from the freezing tanks to cool the water in the forecooler. This, in my opinion, is not economical, since it usually results in superheating the gas returning to the compressor, diminishing the capacity of the compressor by allowing less weight of gas to enter than would otherwise enter.

Keep in mind that refrigeration is based on the *weight* of ammonia evaporated—the lighter the gas returning to the compressor the more revolutions the machine has to make to handle the same weight of gas.

The use of thermometers will show at what temperature the gas returns, and any ammonia table will then show how many cubic feet of gas at that particular temperature are required to weigh a pound. If, for instance, the back pressure is 15.67 lb., the temperature of the ammonia would be 0 deg. F., and it would take 9 cu.ft. to make one pound. Now assuming that the thermometer shows 31 deg. F., or 31 deg. superheat, it would take 9.682 cu.ft. to make a pound, or about 8 per cent. loss. This also shows how important it is to have the ammonia return pipes covered. Many owners look on the pipe covering as an unnecessary expense; as a matter of fact, it is absolutely justified and pays for itself in a short time. This refers also to distilled or cooled-water lines to can fillers.

Loss of Ammonia a Source of Complaint

One of the usual complaints is the loss of ammonia, and this is always a serious matter. You can read any number of articles about the deterioration of ammonia, yet if you talk to an ammonia salesman representing a concern whose goods you are not using, he will tell you in a minute that all you have to do is to buy his ammonia and that will settle the whole question. I can truthfully say that I have never found any appreciable difference in the ammonias made by several reputable concerns. When there seem to be no leaks it is most perplexing to tell where the ammonia disappears to, and again, in other plants of similar construction, the leakage losses are really insignificant. The two places where the chances for losing the ammonia are the greatest are in the stuffing-boxes and the condensers. It is important not to allow the stuffing-boxes to leak, and to regulate the return gas so that it will have, if possible, the same temperature continuously to avoid heavy back frost, which invariably causes leaks around stuffing-boxes. If the engineer then tightens the stuffing-box to prevent this temporary leak, the chances are that later the piston rods will run hot or even cause the gland bolts to break, as I have seen happen several times.

As far as the condensers are concerned, it is natural that the danger of leaks is greater there on account of the high pressure as well as the fact that the water running over them will absorb the ammonia, so that numerous small leaks may exist for a long time without being found. When there is a perplexing loss of ammonia, I think it would be well to shut off the water over one or two condenser coils at a time, and go over them carefully. The possibility of leaks in the brine-tank coils makes it desirable to periodically examine the brine by means of Nessler's or any other suitable reagent. Peculiarly, leaks are often near the bottom f the tank and in an inaccessible place.

If the leak is not very strong, although it is a matter of fine judgment to determine that, it may be advisable to let it go until the cool season, since the operation of emptying the brine tanks, removing the ice cans, refilling, etc., is one of the worst things that can happen in an ice plant and emphasizes the importance of having only the best steel or malleable fittings and flanges and wrought-iron piping and thorough tests under pressure before the brine is put in. In many plants this is not done thoroughly enough for the simple reason that the contractor often is late with his work and does not take the proper time to test after the plant is installed. That is wrong, since it is better to finish the work a few days later than to have to interrupt the whole plant or at least one tank during the warm season for never less than a week and sometimes even more.

Leaks are started by the cans being dropped on the pipes, and sometimes on account of the brine being allowed to get weak, the cans freeze in the brine and the coils are bent by using crowbars to get the cans loose. Weak brine may freeze into the coils, forming an insulation, retarding the freezing action and cutting down the capacity. In addition, as previously stated, it may cause the more serious trouble of ammonia leaks. See to it that the brine agitators are run at the right speed. Unfortunately, the machines driving them are often of a cheap and poor make and require constant attention. Insufficient agitation means lower efficiency of tank.

One point that usually received very little attention is the water jacket of the compressors. I have inquired from several operating engineers what instructions they had received from the contractor's engineer. In no case had they received any direct instruction, and the handling of the water jacket was left to their own judgment. Generally, the water jacket should have as large and as cold a water-supply as one can manage to give it. Whatever heat is removed by the water in the jacket reduces the amount of power required to drive the compressor. I have seen the water in jackets frozen solid, caused by liquid being allowed to return to the compressor in sufficient quantity to freeze the water.

Tests of Welded Joints

A series of tests of the strength of oxyacetylene-welded joints in mild-steel plates has been completed by the Engineering Experiment Station of the University of Illinois under the direction of H. F. Moore, research professor of engineering materials. Specimens were supplied by the Oxweld Acetylene Co., of Chicago, and tests were made in the laboratories of the station at Urbana under three conditions of loading: (a) Static load in tension (in a testing machine), (b) repeated load (bending), and (c) impact in tension (in a drop testing machine).

For joints made with no subsequent treatment after welding, the joint efficiency for static tension was found to be about 100 per cent. for plates one-half inch in thickness or less, and to decrease for thicker plates. For static tension tests, the efficiency of the material in the joints welded with no subsequent treatment was found to be not greater than 75 per cent. The joints were strengthened by working the metal after welding and were weakened by annealing at 800 deg. C. (1472 deg. F.) For static tests and for repeated stress tests the joint efficiency sometimes reaches 100 per cent.; the efficiency of the material in the joint is always less. This indicates the necessity of building up the weld to a thickness greater than that of the plate. The impact tests show that oxacetylene-welded joints are decidedly weaker under shock than is the original material; for joints welded with no subsequent treatment the strength under impact seems to be about half that of the material.

In general the test results tend to increase confidence in the static strength and in the strength under repeated stress of carefully made oxyacetylene-welded joints in mild-steel plates. The results of these tests have been published as Bulletin No. 98 of the Engineering Experiment Station, copies of which may be obtained without cost by addressing C. R. Richards, Director, Urbana, Illinois.

North Jersey Severely Suffering from Coal Shortage

The industries and homes of Northern New Jersey are in the grip of a most severe coal shortage as this goes to press. The two large stations of the Public Service Electric Co., Marion and Essex, which supply much of North Jersey with electricity for industries, railways and homes, are hobbling along with but one turbo-generator running in each plant. These stations consume 1200 tons of coal per day of the pooled coal which they have been getting, but nowhere near this amount is coming in. All the company's coal reserve is used up, and though according to the Fuel Administrator's books the company still has 400 tons in the pooled coal pile, there is no pile. Some one has overdrawn his account, evidently.

The Public Service has reached the point where its officials have given up in despair. Seeing the shortage coming, it paid out a million dollars bonus to get coal; but before it reached the company's yards it was pooled or directed elsewhere. It has put the situation up to Fuel Administrator Jenkinson, who has one of his best men at work trying to keep the Public Service supplied with enough coal so that further curtailment of service will not be necessary. Many carloads of coal were on the way to the company's yards; but word came (Wednesday, Jan. 2) that these had been directed to other more urgent uses by the Government.

Wednesday, Jan. 2, the circuit-breakers were pulled and most of the industries using the company's service cut off. This came after urgent appeals to consumers to reduce consumption had failed to get results. Many of the engineering staff sat in the offices at the Terminal Building, Newark, Wednesday night and directed the load dispatcher in an effort to effect the most equitable distribution of current. The electric street lights were not turned on until 7:30 p.m. to make available enough current to carry the trolley service over the rush-hour period.

Among the industries affected by the Public Service coal shortage are munition factories and others engaged in related work. Many of those consumers who have their own plants, but use in addition purchased current, are shut down only in those departments supplied with purchased current, though several factories are without coal for their own plants. What little coal there is at Perth Amboy, the distribution center for New York City and this section of New Jersey, is frozen into lumps, each lump filling a car.

This period of "short rations" will last at least a week, say the Public Service officials, and how much longer they do not know. Hoboken at this writing has no water, electricity, gas or coal. The locomotives in the Jersey City yards have no water and power plants are down. The great Edison plant at West Orange, the Westinghouse Lamp Works, Newark, part of the General Electric Co.'s Harrison plant, and the American Shell Co., Paterson, are closed.

The whole of North Jersey is not only hobbling along on a very greatly reduced electrical supply, but trolley service is seriously inadequate and the gas supply has been shut off from whole counties.

Heating Buildings With Sprinkler Systems

The increasing use of automatic sprinklers in modern commercial industrial buildings has led to the development of the sprinkler system for heating purposes, according to E. S. Densmore, in the *Quarterly* of the National Fire Protection Association. As is well known, the sprinkler system consists in general of a series of pipes which cover uniformly the ceilings. If the water which is maintained in the system can be heated and circulated, evidently the sprinkler piping can be used for heating. One fundamental objection is that the sprinkler head which is in ordinary use will melt at the temperature necessary for the water to be used for heating purposes. This melting of the sprinkler head is prevented by a U-connection through which the hot water cannot circulate. In practice it has been found that a bend in the horizantal nipple carrying at the end the upright sprinkler head will prevent the head from melting.

The connections of the hot-water heating system with the sprinkler piping are exceedingly simple and need not change the sprinkler piping in any way. The hot-water heater may be located in any convenient place. From the hot-water heater a hot-water supply pipe is run and connected to the foot of the sprinkler riser inside the sprinkler alarm valve. It is advisable to provide an ordinary stop valve at this point so that the hot-water supply may be entirely shut off from the sprinklers when necessary. Between the hot-water connection to the riser and the sprinkler heads no changes are made, the riser, laterals and distributing pipes being installed in the usual way. Many successful installations have been made, and apparently no fundamental difficulties have been encountered over a period of several years in operation.

Insolvency's Effect on Power Contracts

When a power company becomes insolvent and its affairs are entrusted to a receiver, who continues to operate the property for the benefit of the company's creditors, he is not bound to carry out a preëxisting contract of the company to furnish power to a particular customer. It is left to the receiver's judgment, acting under control of the court, whether he will adopt such a contract or repudiate it according to what is deemed to be for the best interests of the estate. In the absence of indication of his election to the contrary, the contract becomes automatically dissolved on the receiver's appointment. But in this case it is decided that the receiver of an electric-power company, who agreed to supply power to a manufacturer, under an independent contract entered into by him, should not be permitted to recover a fixed charge for keeping power in readiness for service whether needed or not, in the absence of proof that he had agreed to and did keep the amount of power supplied, whether used or not. (Iowa Supreme Court, Maxwell vs. Missouri Valley Ice and Cold Storage Co., 164 Northwestern Reporter, 329.)

Liability for Defective Condition

Since it is a general principle of law that one is not liable for injury sustained by another on account of a defective condition of premises, unless the defect had been previously known to the former, or had existed so long as to fairly charge him with constructive knowledge of the conditions, and ample time had elapsed in which the defect might have been repaired, the owner of a steam-power plant is not liable for injury to a pedestrian, caused by a break in a steam pipe line under a pathway used by the public where it appears that the break must have occurred between 4 o'clock in the afternoon and 11 o'clock that night, and that those in charge of the plant had no notice of the break before the accident to the pedestrian occurred. (Truschine vs. Fayette Manufacturing Co., 63 Pennsylvania Superior Court Reports, 124.)

"Coal Savers" in Great Britain

From the following it is evident that the United States is not the only territory that has been invaded by the so-called "Coal Saver." *Power* has published a number of articles dealing with compounds that are supposed to increase the heat value of coals if sprinkled upon them or when sprayed over ashes, and various preparations are extensively advertised in Great Britain at present which are presumed to contribute considerably to the heating power of coal when applied in the prescribed process.

The Director of Fuel Research, in answer to an inquiry as to the value of these preparations, states that these proprietary substances have been in the market a long time, but that there does not appear to be any genuine scientific evidence in support of the claim of their manufacturers. He concludes: "The nature of the substances makes it highly improbable that they have any effects whatever on the combustion of coal or other fuels when they are used in the quantities prescribed."

Personals

O. L. Ruley, formerly with the Union Traction Co., of Indiana, is now superintendent of the Portland Municipal plant, at Portland, Ind.

E. M. Walker, formerly manager of the Dubuque (Iowa) Electric Co., is now general manager of T. H. I. & E. Traction Co., at Terre Haute, Ind.

George W. Schmidt, formerly chief engineer of the Dubuque (Iowa) Electric Co., is now chief engineer at T. H. I. & E. Traction Co., Terre Haute, Ind.

M. H. Owens, formerly manager of Hobart City plant, Hobart, Ind., is now manager of the Inter-State Public Service Co., for Columbus and Seymour, Ind.

H. E. Smith, formerly chief engineer at T. H. I. & E. Traction Co., Terre Haute, Ind., is now chief engineer of the Indianapolis (Ind.) Light and Heat Co.'s Mill Street plant.

Charles H. Parker, who has been with the Edison Electric Illuminating Co., of Boston, for the last 22 years, has been appointed superintendent of the generating department, of which he has been assistant superintendent for 17 years.

Milton Kraemer, consulting engineer, of San Francisco, has undertaken an investigation into the utilization of coals, mined in California and neighboring states, for use as fuel in a pulverized form. This will be a continuation of a study made in 1916 and the early part of 1917, for some of the large California power companies.

Frank W. Hall has been appointed commercial manager of the Sprague Electric Works of General Electric Co. With the exception of a short period, Mr. Hall has been connected with the Sprague Works continuously for 22 years in various engineering and sales capacities, and for the three years prior to his present appointment occupied the position of sales manager. He succeeds D. C. Durland, former executive head of the Sprague Electric Works, who resigned to accept the presidency of the Mitchell Motors Company, Inc.

Business Items

Gannestad & Jacobsen, engineers, of Pittsburgh, Penn., have removed from the Benedum-Trees Building to Suite 1103-1106, B. F. Jones Building, where they have more spacious quarters to take care of increasing business.

Engineering Affairs

Fuel Conservation in Boiler Rooms is the subject of a meeting under the auspices of the Baltimore Section, American Society of Mechanical Engineers, the Engineers' Club of Baltimore and the City Club at the rooms of the last, Thursday evening, Jan. 10. Efforts are being made to have a large attendance of firemen, among others. Charles H. Bromley, associate editor of "Power," will give the main address of the evening, followed by W. L. DeBaufre, of the United States Naval Experiment Station, Annapolis, Md., and others. The meeting will be the first of a number to arouse more general interest in fuel economy in boiler plants.

Miscellaneous News

Public Hearing on New Jersey Boiler Code—Before the code formulated by the State Board of Boiler Rules is adopted finally, a public hearing will be held at which minor changes will be discussed. This was the decision of the board at a conference recently held, presided over by J. F. Scott, chief of the License Board of the Bureau of Engineers.

According to the November Bulletin of the New York State Department of Labor, the metals, machinery and conveyances group had an addition of more than 1 per cent. to the number of employees, and paid 3 per cent. more wages in November than in October. The water, light and power group in November had more than 1 per cent. additional employees, and a slightly greater payroll than in October. As compared with the corresponding month of last year, November reported gains of 4 per cent. in the number of employees and 19 per cent. in the wage volume.

New Power Site Reserve—The Secretary of the Interior recently recommended, and the President has approved, the inclusion within a power-site reserve of about 196 acres of public land in the Big Sandy River Basin, Oregon, in order that this land may be used in connection with the development of power, but not for other purposes. Big Sandy River has its source on the western slope of the Cascade Range, and its principal tributaries are fed by the glaciers of Mount Hood. The land recommended for withdrawal is located near or adjacent to Big Sandy River below the mouth of Salmon River.

The withdrawal for power-site purposes of a tract within the Eldorado National Forest, Cal., has also been recommended by the Secretary of the Interior and approved by the President.

Free Class for Radio Operators at Stevens Tech.—A free evening class to train men as radio operators for the Signal Corps will soon be started by the Stevens Institute of Technology at Hoboken. Those who actually expect to be called to the colors will be admitted into the class if prompt application is made to Prof. L. A. Hazeltine, head of the Department of Electrical Engineering, under whose supervision the course will be conducted. The definite object of the course which will require four evenings each week, is to develop radio or buzzer operators so as to be able to send a minimum of 20 words per minute. Upon finishing the course, which requires about 200 hours, less for some and more for others, a certificate of attainment will be given. The course is offered specifically for those who desire to enter a cantonment trained and ready to do a specific job. The authorities at Washington state "that drafted men who attain the required proficiency are practically certain of rapid promotion and increased pay in the Army. The rank of corporal and sergeant with a wage of from $36 to $51 a month awaits the majority of men thus trained, and in proportion as a man so instructed shows his ability and interest, promotion lies ahead of him to the position of Master Signal Electrician, with a wage of $81 a month.

The Army and Navy Staff Departments continue to demand men of engineering experience, especially in industrial lines. At present the outlook is that this demand will continue throughout the period of the war. In calling attention to this, the United States Public Service Reserve, Washington, D. C. (where records of men willing to serve when called will be kept on file), points out that a man of engineering experience has a rare combination of opportunities open to him, which are not open to the average patriotic American, as follows: (1) To serve the country in his most effective capacity; (2) to keep in touch with his own profession, with the result that his patriotic service will not have caused him to become rusty by the time peace returns; (3) to become a commissioned officer and receive much better pay than the average man who has wholly subordinated personal interests and now works for the national good; (4) to perform his service usually without leaving the United States

Technical Troops for France—Skilled engineers and "handy men" wanted, 18 to 21 or 31 to 40. Jerseymen, volunteer before these regiments are filled from other states. There are now being organized and enlistments are invited for (N. A.): 20th Engineers (Forestry), 23rd Engineers (Highway), 24th Engineers (Shop and Supply), 25th Engineers (Construction), 26th Engineers (Water Supply), 27th Engineers (Mining), 28th Engineers (Quarry), 30th Engineers (Gas and Flame), 37th Engineers, 38th Engineers (Crane Operators), Engineers Unassigned, Washington, D. C. All applicants are enlisted as privates; but may soon advance as corporals and sergeants when found qualified. Applicants must have the same physical examination as any other recruits. A technical worker or handy man in any of the mechanical industries will find in the above field of enlistment a rare opportunity. If of draft age no man can volunteer. Enlistment is for the period of the war only. No cards from Engineer Officers are required except for 37th and 38th Engineers (N. A.) The enlisted personnel of the Engineers N. A. (Crane Operators) will be approximately as follows: 200 locomotive crane operators (operation of railway constructing derricks, cargo-handling machinery on lake, ore and coal docks and first-class steam shovel runners), 32 Rotary Tenders, 16 Armature Winders, 16 Electrical Foremen, 16 Storage Battery Charging Men, 16 High Tension Wiremen, 144 Journeymen Electricians, 8 Cooks. It is proposed to limit enlistments in the 37th and 38th Engineers N. A., to those men whose vocational training has been examined and approved by officers representing the Engineer Department. Applications for enlistment in the 37th Engineers should be addressed to Chief of Engineers, Washington, D. C., and in the 38th Engineers to same or to the Director General of Railways, Washington, D. C. For the other Engineer Regiments (N. A.) apply direct to any recruiting office. The above regiments are National Army. In addition, men are accepted for the Engineers, regular army. Recruiting stations: Main office, 86 Park Place, Newark, N. J., near McAdoo Terminal; Paterson, 269 Main St.; Passaic, 215 Main Ave.; Elizabeth, 55 Broad St.; Trenton, 103 E. State St.; New Brunswick, Post Office Bldg.; Atlantic City, 1536 Atlantic Ave.; Perth Amboy, 130 Smith St.; Camden, 540 Federal St.

Volunteers Wanted in Ordnance Corps—For every man on the firing line there are skilled men back of the line upon whose help and coöperation he depends. The enlisted Ordnance Corps of the National Army, into which the Ordnance Enlisted Reserve Corps has been merged, is that army behind the army which the great war has made more important than ever before. Unless the fighting man in the front-line trenches has the help and skilled coöperation of specialists behind him, his work is seriously hampered. This is a war of specialists, and a man can serve his country efficiently by applying the result of his civilian experience to the work of the army. In the Enlisted Ordnance Corps, the skilled man continues the same type of work he pursues in civil life. The acceptance or card from an ordnance officer is no longer needed. The chief of ordnance is charged with the supply, maintenance, and repair of all cannon and artillery vehicles and equipment; all machines for the service and maneuver of artillery; all small arms, ammunition, harness, motor trucks, motor cycles, railroad cars, and also every device for the mechanical service of the front-line army. There is a definite place in the ordnance corps for the skilled man in almost every line of trade: Machinists, mechanics, plumbers, painters, tinsmiths, carpenters, auto mechanics, saddlers, blacksmiths, and wheelwrights are especially needed at this time. Military training, while desirable, is not essential, as men will continue the type of work they pursue in civil life, thus saving the Government a long period of instruction, and also greatly improving their own chances for advancement. If you are a skilled artisan, join the army behind the army. If handy with tools, perfect yourself with these technical troops. If accepted for enlistment, men will ordinarily be sent to an arsenal for a short period of instruction, upon completion of which they will be assigned to detachments, units, or organizations, with ultimate service abroad. Applicants must be between 18 and 21 or 31 and 40 years, and must be able to pass a physical examination conforming to that prescribed for the regular army. Registrants are not eligible for voluntary enlistment. In view of the work of the Enlisted Ordnance Corps, National Army, and the fact that the men in the first-line trenches depend upon their help and coöperation, a large number of men will be promoted as noncommissioned officers. Pay ranges from $30 to $61.20 a month, depending upon demonstrated ability and place of service. Enlistment is for the duration of the war only. In addition to the regular pay, free quarters, rations, clothing, bedding, medical and dental attention are provided by the Government, and 20% increase while on foreign service. There are also vacancies in other branches of technical troops: Aviation; Quartermaster Corps; Engineers; Sanitation, Hospital Corps; Heavy Artillery, Field Artillery. Also in the line: Infantry, Cavalry, U. S. Guard, etc.

How to enlist: If you are a mechanic or have a trade, call either at the Main Army Recruiting Station for New Jersey, at 86 Park Place, Newark, N. J. (near the McAdoo Tube Terminal), or at any of the following branches: 540 Federal St., Camden; 130 Smith St., Perth Amboy; 103 E. State St., Trenton; 55 Broad St., Elizabeth; 269 Main St., Paterson; 215 Main Ave., Passaic; Post Office Bldg., New Brunswick; 1536 Atlantic Ave., Atlantic City.

If working during the day, call until 9 P.M. for information.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Jan. 3, 1918	One Year Ago	Jan. 3, 1918	One Year Ago
Buckwheat	$4.60	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.10	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	3.90	.....	.....	.....
Barley	3.60	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Bituminous not on market.

	F.o.b. Mines*		Alongside Boston†	
	Jan. 3, 1918	One Year Ago	Jan. 3, 1918	One Year Ago
Clearfields	.....	$3.00	.....	$4.25—5.00
Cambrias and Somersets	.....	3.10—3.85	.....	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago.

*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Jan. 3, 1918	One Year Ago	Jan. 3, 1918	One Year Ago
Pea	$5.05	$4.00	$5.80	$6.00—7.00
Buckwheat	4.30—5.00	2.75	5.05—5.75	5.50—6.00
Rice	3.75—3.95	2.20	4.50—4.75	5.00—5.50
Barley	3.25—3.50	1.95	4.00—4.25	3.75—4.00
Boiler	3.50—3.75	2.20	4.00—4.50	.....

Bituminous smithing coal, $4.50—5.25 f.o.b.
Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate)	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide		Independent
	Jan. 3, 1918	1 Yr. Ago	Jan. 3, 1918	1 Yr. Ago	One Year Ago
Buckwheat	$3.15–3.75	$2.00	$3.75	$2.90	$4.15
Rice	2.65–3.65	1.25	3.65	2.15	3.35
Boiler	2.45–2.85	1.10	3.55	2.00	...
Barley	2.15–2.40	1.00	2.40	1.90	2.35
Pea	3.75	2.80	4.65	3.70	...
Culm	....	....	....	....	1.25

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.10—3.25
Mine-run	2.40—2.55	2.85—3.00
Screenings	2.15—2.30	2.60—2.75

Smokeless Coals	So. Illinois, Pocahontas, Pennsylvania and West Virginia	Hocking, East Kentucky and West Virginia Splint
Prepared sizes	$2.60—2.80	$3.05—3.25
Mine-run	2.40—2.60	2.40—2.60
Screenings	2.10—2.30	2.10—2.30

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Jan. 3, 1918	One Year Ago	Jan. 3, 1918	One Year Ago	Jan. 3, 1918	One Year Ago
6-in. lump	$2.65–2.80	$3.50	$2.65–2.80	$3.50	$2.65–2.80	$3.50
2-in. lump	2.65–2.80	....	2.65–2.80	....	2.65–2.80	3.50
Steam egg	2.65–2.80	3.50	2.65–2.80	3.50	2.65–2.80	3.50
Mine-run	2.40–2.55	3.50	2.40–2.55	3.50	2.40–2.55	3.50
No. 1 nut	2.65–2.80	3.50	2.65–2.80	3.50	2.65–2.80	3.50
2-in. screen	2.15–2.30	3.50	2.15–2.30	3.50	2.15–2.30	3.50
No. 5 washed	2.15–2.30	3.25	2.15–2.30	....	2.15–2.30	....

Williamson-Franklin rate St. Louis, 87½c.; other rates, 72½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba	2.40	2.65	2.15

Government figures.

[1]Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Ala., Mobile—The Mobile Electric Co. plans to build a 5-mi. transmission line to the Chickasaw Shipbuilding plant now under constructon. T. K. Jackson, Mgr.

Ark., Stuttgart—S. R. Morgan & Co., Little Rock, has been granted a franchise to build and operate an electric-lighting and power plant. Estimated cost, $100,000.

Calif., Palo Alto—The City Council plans an election soon to vote on $6600 bonds for the installation of a Diesel engine and an electric generator for the power plant.

Colo., Salida—The Colorado Power Co. plans to double the capacity of its local steam plant in order to supply the Rawley mine with electricity. W. E. Robertson, Mgr.

Ga., Atlanta—City plans to install an electric generating plant at the city incinerating station. A. Turner, City Electrician.

Idaho, Shelley—City plans to install an electric-lighting system.

Ill., Joliet—The Chicago & Joliet Electric Ry. Co. plans to build 2 substations, 1 at Osgood and St. Louis Sts. and the other at Delwood Park. Estimated cost, $50,000. J. R. Blackhall, Gen. Mgr.

Iowa, Marshalltown—The City Council plans to build a new electric-lighting plant and install new machinery and equipment. W. H. Steiner, Engr.

Kan., Burns—City plans to install an electric-lighting plant. Estimated cost, $10,000. C. A. Beebe, City Clk.

Md., Mt. Savage—The United Big Vein Coal Co. plans to install electrical mining machinery and completely electrify its plant.

N. J., Hightstown—Grover Bros., Broad St., plans to install an electric-lighting plant in connection with its works.

N. Y., New York—(Borough of Brooklyn)—The Transit Development Co., subsidiary of the Brooklyn Rapid Transit Co., has had plans prepared for the erection of an addition to its generating power station on Kent and Division Ave. Estimated cost, $500,000. H. A. Robbins, 85 Clinton St., Supt. of Power.

Ohio, Cleveland—City is having plans prepared by F. H. Betz, Arch., City Hall, for the erection of a 4-story, 80 x 250-ft. addition to its electric-lighting plant on 53rd St. Estimated cost, $1,750,000. Noted Sept. 25.

Ohio, Cleveland—The New York Central R R. plans to build a 40 x 79-ft. power house and install new electrical equipment, generators, motors, etc., here. J. W. Kittredge, New York City, Ch. Engr.

Okla., Durant—The Consumers' Light and Power Co. plans to rebuild and equip its electric-lighting plant which was damaged by fire. W. H. Williams, Engr.

Okla., Miami—The Bilharz Mining Co. plans to build a central electric generating plant to supply power for plants 1, 2 and 3.

Ont., Perth—The Hydro-Electric Commission plans to build a 26,400-volt transmission line between Perth and Smith's Falls.

Ont., Wiarton—The Hydro-Electric Power Co., Ontario, is having plans prepared for an electric-light and power plant to be erected here.

Ont., Windsor—The City Commissioners plan to install 2 new electrically driven pumps in its pumping plant.

Penn., Coaldale—The Panther Creek Valley Hospital is having plans prepared by L. Stockton, Arch., 35 West 39th St., New York City, for the erection of a 1-story power house. Estimated cost, $8000.

Que., Valleyfield—The Montreal Cotton Co. plans to rebuild its power plant which was recently destroyed by fire. Loss, $100,000.

S. D., Presho—O. E. Helgerson has been granted a franchise for the installation of an electric-lighting system.

Tex., Marfa—The Marfa Electric and Ice Co. plans to install additional machinery in its electric-lighting and power plant.

Wash., Glacier—The Lone Jack Mining Co. plans to install a power plant at its works on Silesia Creek. Estimated cost, $20,000.

Wash., Seattle—The Puget Sound Machinery Depot is having plans prepared for the erection of a 160 x 240-ft. boiler shop and will install new machinery and equipment in same.

W. Va., Ansted—The Mill Creek Colliery Co. plans to rebuild its power plant which was recently destroyed by fire. Loss, $40,000.

Wis., Kaukauna—The Kaukauna Electric Light Co. plans to extend its transmission line to Fairview Heights. W. B. Montgomery, Mgr.